how to SOLVE BIG PROBLEMS like PREEMIE SURVIVAL in South Africa

Social Innovation Through Systems Design

Klara Joubert

Acknowledgments

I would not have been able to complete this project without the generous support and input from the nurses, midwives, pediatricians, neonatologists, healthcare providers, educators, and researchers who helped me understand this subject by discussing their experiences and evaluating my design solutions.
Thank you for all that you do every day. You are unsung heroes.

Supporting a design student throughout their degree is no small feat.
To my professors – thank you for your patience, wisdom, and mentoring.

To my family – thank you for the cups of tea at my desk, the pep talks, and the unwavering support. To my friends – thank you for listening to me drone on and on about systems design, and for helping me hash out my ideas.

Finally, thank you to the parents of premature babies all over the world. By sharing your raw, vulnerable experiences, you make it possible for a project like this to exist.

This project would not be possible without the generous support and funding from Kwantlen Polytechnic University's Student Research Innovation Grant (KPU SRIG 2024-70). Thank you to the Office of Research Services for their support in this grant. Receiving this grant made it possible for me to travel to South Africa, where I continued my research and gained a deeper understanding of how to develop my design solutions so they can flourish in their intended environment.

WILSON SCHOOL OF DESIGN KPU

Abstract

This design report covers the journey of my 4th year capstone project for my undergraduate degree in Product Design. It describes my experiences moving through the design process, moving through numerous research, ideation, testing, and prototyping phases.

I explored the critical issue of post-discharge care for premature infants in South Africa focusing on the development of a digital health intervention, NeoNu, to bridge the gap between hospital discharge and home care. The research employed a systems thinking approach, utilizing tools like cause-effect loops, Ishikawa (fishbone) diagrams, stakeholder mapping and leverage wheels to understand the complex interplay of factors affecting post-discharge care. Ethnographic research, including hospital visits and interviews with healthcare providers and caregivers, provided crucial insights into the real-world challenges faced by families. The study revealed that a significant percentage of families do not return for follow-up appointments, highlighting the urgent need for accessible, at-home monitoring tools.

Premature infants face numerous environmental and biological risk factors post-discharge, which contribute significantly to adverse health outcomes. South Africa's healthcare system often struggles to provide adequate support, especially in resource-constrained settings where there are limited

healthcare facilities. Parents and caregivers of premature babies face complex environmental and socio-economic constraints, leaving them without the necessary tools and support to monitor their baby's health post discharge, or to attend regular followup appointments.

NeoNu, a mobile application, was designed to address these challenges by enabling parents to track their infant's health, identify warning signs, and facilitate communication with healthcare providers. The app focuses on monitoring key indicators such as feeding, growth, and potential infections, providing timely alerts and educational resources. The design process emphasized the importance of a low-cost, user-friendly solution, adaptable to the South African context.

Findings from user testing and healthcare provider feedback validated the feasibility and potential impact of NeoNu. The app addresses critical gaps in post-discharge care, offering a scalable solution to improve health outcomes for premature infants. This project demonstrates the potential of digital health interventions to enhance healthcare delivery in resource-limited settings, emphasizing the need for continued development and implementation of such tools to support vulnerable populations.

CONT

TENTS

1

Context

> Personal background and Motivation
> Defining the Design Challenge: a Systems Design Methodology

Personal Background and Motivation

Figure 1: Prince Albert, My Home Town

Just before I turned three, my family left the urban sprawl of Pretoria and moved to Prince Albert - a small, dusty town in the heart of the Great Karoo in South Africa.

Years later, when I asked my parents why they decided to move there, they casually mentioned a Sunday drive where they decided it looked like “a good place to raise happy, barefoot children.” And so, they sold their house, packed up their little family, and plunged us into the heart of the semi-arid Karoo.

My brother and I spent our days outside in the Karoo sun, playing in the leivoor (irrigation ditches), catching frogs, and getting up to all sorts of mischief. This upbringing cemented in me the age-old truth that ***necessity is the mother of invention***. There is nothing quite like boredom to give you a sparkling idea.

My father, a big thinker (he started his company in university, basically the founder of “working from home”), and my mother, who traded environmental law for raising us, were both forces of nature. Mom, in particular, channeled her drive into meaningful community projects. When I was home sick from school, I would go with her to the various community projects she was involved with. I watched as real people came together every day to bring about real change. I didn’t know it at the time, but this sparked my love for social innovation.

Figure 2: My Mom (Ellen) and Dad (Anton)
Figure 3: Mom at the Town’s Recycling Project

Figure 4: Albert College

As I grew older, I went to a small school called Albert College. Our school motto was “It all Depends on You.” At first, this may sound intense. Like a burden, even. But truer words were never spoken. We were taught that effort equals reward; you can build a beautiful life if you show up, see the need, and dive in headfirst. Once you’ve tasted that kind of agency, it’s hard to approach anything differently. We learned that we can’t wait for someone else to fix things – we must take action ourselves.

Figure 5: Me and my Brother, Siemon

South Africa has a challenging, messy, and unique history. As South Africans, we are a resilient, complex, beautiful people, living in a resilient, complex, beautiful country. I learned the value of community early on. In a small town, everyone is equal. My mother always said the local lawyer’s job is just as vital as the rubbish truck driver’s. If either dropped the ball for a week, the whole town would feel it. Community means everyone stepping up and contributing to a shared goal.

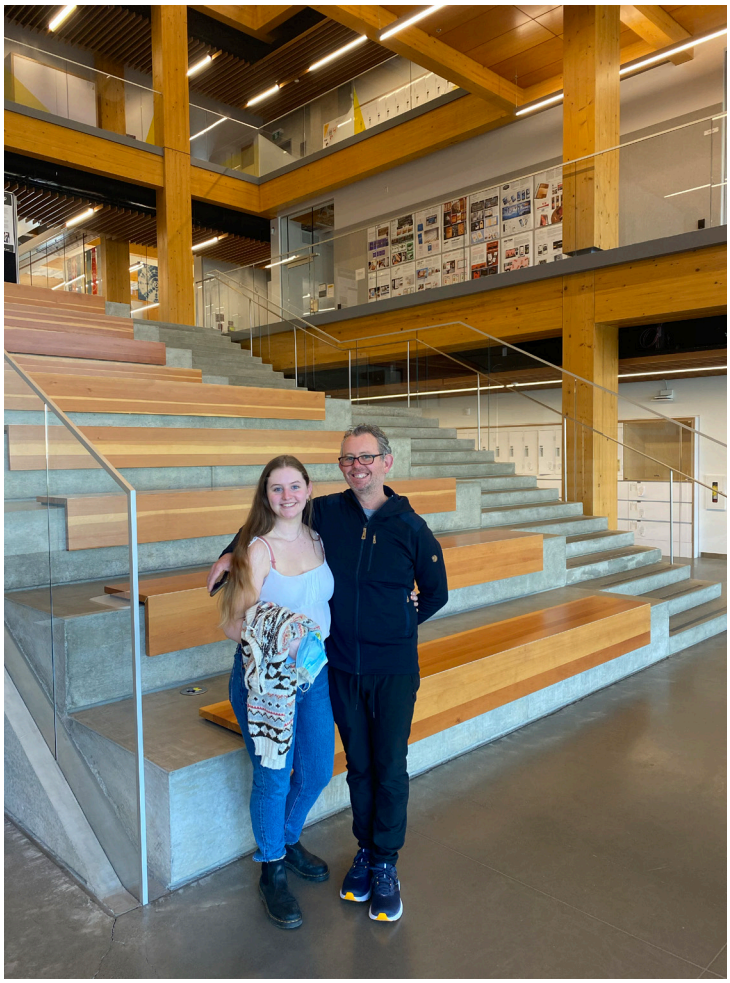


Figure 6: My First Day at KPU in Canada

Years later, I arrived in Canada bright eyed and bushy tailed, ready to start my degree in Product Design. The culture shock of immigrating halfway across the world was immense. Suddenly "design for meaning" meant debating sustainable materials for three figure leggings. Suddenly "community" became polite $8 coffee chats. And "making a difference" felt like superficial gestures. I grappled with this shift. What about everyone back home who had no power for days on end? What about those fighting every day in a crumbling economy?

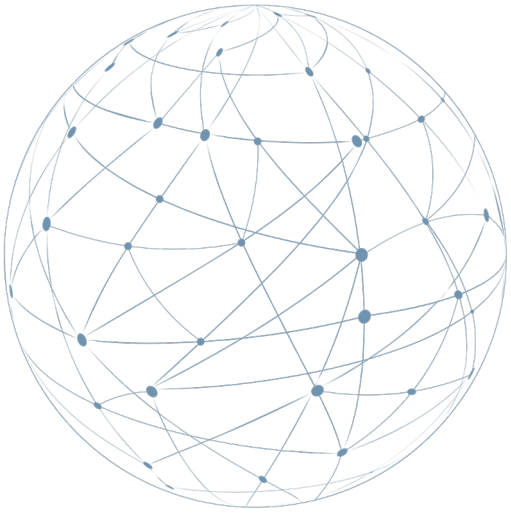
What about my people?

That is why, when the time came for my capstone project, I knew I wanted to make it matter. Really matter. I count myself lucky to have grown up the way I did, and I wanted to channel my unique background into creating something powerful and impactful. I wanted to give back to South Africa for all it has given me.

Defining the Design Challenge – a Systems Design Methodology

How do we make a positive impact through design?

This question haunted me as I embarked on my capstone year. I wanted to use my capstone project as a trial run for tackling a complex social innovation problem, but it left me with the question: how do we solve a big problem? Hell, how do we even **IDENTIFY** which big problem to solve?



I pitched three pressing South African issues to my professors: gender-based violence, preterm infant mortality, and gendered poverty in rural areas. We narrowed it down to preterm infant mortality rates, a slightly more feasible, though still daunting, challenge.
My topic was still incredibly broad, so I needed a way to pinpoint the core issue before attempting any solutions.

Enter systems design.

Figure 7: A Premature Baby in an Incubator

Figure 8: Systems Mapping Exercise from Previous Projects

Systems design, which I was introduced to in my second year of university, helps identify "leverage points" – key areas where interventions can have the most significant impact. It involves four phases:

- *Structuring the problem*
- *Understanding and intervening the system*
- *Creativity and creating certainty*
- *Implementation (putting the solutions into action)*

Each phase uses design thinking exercises and mapping to frame the problem, explore its causes, and develop solutions. I'll delve deeper into these phases in the following chapters.

2

Discovery

- Preliminary Research
- Building out the picture with Literature review
- Filling in the gaps with Interviews
- Bringing it all together

Chapter 2 - Discovery

Preliminary Research

The first order of business was getting into some research and understanding the bare bones of the problem. I had a loose research question in my mind: “How might we lower the number of deaths of premature babies in South Africa?”
I approached my research with a mixed-methods design. A mixed methods approach can be described as one where “researchers combine elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration.”[1]

Some of my early findings helped frame the issue of preterm birth and death rates both globally and locally (in South Africa).

Globally:

- “Preterm births occur earlier than 37 weeks of an expected 40-week full-term pregnancy [2]
- “Globally, an estimated 13.4 million babies were born premature in 2020, with nearly a million dying from preterm complications [2]
- Globally, preterm birth is now the leading cause of child deaths, accounting for more than one in five of all deaths of children occurring before their fifth birthday [2]

Locally:

- 84,000 babies are born preterm every year [3]
- This equates to 1 in 7 babies being born preterm [3]
- South Africa is ranked 24th in the world for newborn deaths linked to preterm birth [3]
- South Africa is ranked 5th in the world for global preterm birth rates [4]
- 11% of preterm births in Sub-Saharan Africa result in death [4]

[1] Elliot, N., Fox, G., Smith, R., & Zourrig, H. (2018). RSMT course notes

[2] United Nations. (2023, May 10). “silent emergency”: Premature births claim a million lives yearly | africa renewal. United Nations.

[3] South African Government. (2023, November 21). Health commemorates World Prematurity Awareness Month, 22 Nov. Health Commemorates World Prematurity Awareness Month, 22 Nov. https://www.gov.za/news/media-advisories/government-activities/health-commemorates-world-prematurity-awareness-month

[4] Born too soon: decade of action on preterm birth. Geneva: World Health Organization; 2023. Licence: CC BY-NC-SA 3.0 IGO. (https://creativecommons.org/licenses/ by-nc-sa/3.0/igo/)

Globally, **3.4 million babies were born premature** in 2020, with nearly a million dying from preterm complications.

Preterm birth accounts for more than 1 in 5 deaths of children occurring before their fifth birthday.

Only **1 in 10 extremely preterm babies survive** in low-income countries, compared to more than nine in 10 in high-income nations.

South Africa is ranked 5th in the world for preterm birth rates.

11%

of preterm births in Sub-Saharan Africa result in death.

As a rule of thumb in social innovation design, we can look to guidelines like the United Nations Sustainable Development Goals. These goals were outlined by the UN to create a rubric for countries to ensure global prosperity for people and the planet. My project aligned with target 3.2:

By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births.

I knew I was on the right track, and like a hound on the hunt, I set off.

Figure 10: UN SDGs

Building out the Picture With Literature review

Now that I had a basic understanding of the problem, I needed to understand what was causing high mortality rates of premature babies in South Africa. I cast my net wide and dug into a literature review.
As part of my research, I reviewed over 60 peer-reviewed journals and scientific papers from a variety of sources such as the World Health Organization, the International Journal of Gynecology and Obstetrics, PubMed, the South African Medical Journal, the South African Journal of Childhood Health, and the South African Department of Health. From this research I gained a deeper understanding of the effect of preterm birth in South Africa.

Although there is a consensus on South Africa's high preterm birth rates, there is also an acknowledgment that the true national burden remains unknown.[5] I found it challenging to identify specific numbers, as available public health data often had gaps and inaccuracies. The nature of preterm birth is such that it makes it difficult to monitor on a national scale: gestational age at birth is subject to bias, estimated according to the mother's last menstrual period instead of relying on more accurate ultrasounds. This meant that much of what I was reading was only the tip of the iceberg.

[5] Ramokolo , V., Malaba , T., Rhoda , N., Kauchali , S., & Goga, A. (2019). A landscape analysis of preterm birth in South Africa: systemic gaps and solutions. South African Health Review, 2019(01), 133–144.

A common theme across the literature was high neonatal and postnatal death rates. (Neonatal refers to the first 28 days of a baby's life, and postnatal refers to the period after that first 28 days.) I wanted to understand the causes – why are premature babies dying? We can split these causes into three broad categories:

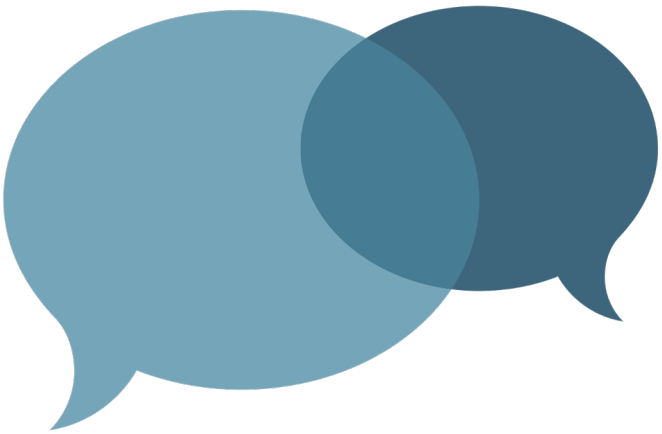
Maternal factors:
These included poor maternal health conditions (like HIV, Tuberculosis, or other infections that can be passed on to the infant), low socioeconomic status, and other complications during pregnancy that could result in premature delivery.

Infant factors:
These have to do with the fact that premature babies (often referred to as preemies) are born with underdeveloped organ and immune systems. Their underdeveloped systems struggle to adapt to the external environment.

Environmental factors:
These are any external factors that may play a role. These were the widest category of causes, as they ranged from cultural stigmas around pregnancy that prevented mothers from seeking care while pregnant, to a crumbling economy which led to an overburdened healthcare system that does not have the resources it needs to support preemies and their families.

The literature consistently highlighted the complex interplay of maternal and environmental factors leading to high preterm birth rates. This influx of premature babies overwhelms the healthcare system, which is overburdened and under-resourced. A vicious cycle ensues as hospitals are forced to discharge families early, and as a result, premature babies face a high likelihood of complications (and even death), placing further strain on the healthcare system.
It was now time to take what I had learned and have some real, challenging conversations about it. I needed to find the needle in this haystack.

Filling in the Gaps With Interviews



A truly human-centered design approach requires direct engagement with those involved. Reading academic papers can only take you so far in understanding the crux of a problem.

As part of my ethnographic research, I conducted primary research in the form of interviews with relevant industry professionals. I started with my own network of people, chatting to nursing students, nurses, early childhood development educators, etc. This network slowly grew as my contacts pointed me in the direction of others who may be able to give me their perspective on the subject: neonatologists, pediatricians, midwives, etc.

My main goal? To narrow down my problem.

I held informal conversations with anyone who was willing – mostly over the telephone or on Zoom. In the beginning, I asked open-ended questions to supplement what I understood about the problem. My understanding of the complex maternal, infant, and environmental factors was confirmed.

Some of the most interesting insights from my conversations were that many hospitals in the Western Cape province of South Africa were extremely well run, in terms of the care provided within the hospital setting.

One of the people I spoke to was a friend who is a nursing student. She happened to be doing her practicals in the maternity ward at the time. Some of the tales she told were harrowing. Clinics and hospitals were overwhelmed, and parents faced language and educational barriers when it came to understanding how to care for their babies.

The nurses and doctors are so overwhelmed with work that they don't have the time to spend hours one-on-one with parents to go over extra resources that will help them understand how to care for their babies better. And it's not because they don't care—it's because they don't have the resources.

Figure 11: Micro Preemie, Born at 26 Weeks Gestational Age and Weighing 311 Grams

A theme in all my conversations was how deeply healthcare workers care about these tiny lives they are saving. A matron explained that her nurses feel the loss of a baby almost as deeply as the family, because they care for these babies for months on end.

A Neonatologist at one of Cape Town's largest hospitals explained that preemies at her hospital are discharged when they reach 1800g. For reference, a full-term baby typically weighs 3.5kg. She explained how the hospital invests so much time and energy into getting the baby from 800g (yes, some really are born this small) to 1800g, but once they are sent home, their health declines so quickly. They are highly susceptible to infections, hypothermia, and growth deficiencies.

Another pivotal conversation was with a Pediatric Surgeon from Cape Town. A team of surgeons had performed life-saving surgery on a pair of conjoined twins, successfully separating them. The twins were in hospital for over a year, receiving the best care. Once they were stabilized, they were sent to a smaller clinic closer to their home. However, within one month, they had passed away due to an infection they picked up.

I had many more conversations that truly brought depth to my understanding of the complexity of the problem I had chosen. Armed with all this information, it was time to step back and look at the bigger picture I had created to choose a path forward. At this point, I was deeply under the impression of how overwhelming it is to solve such a complex issue.

Figure 12: Micro Preemie Jazeel Hlope, Born Near Johannesburg at 25 weeks Gestational Age and Weighing 395 Grams

Bringing it All Together

Figure 13: A Premature baby Receiving Kangaroo Mother Care: Skin-to-Skin Contact with Proven Benefits for Mother and Baby

The solutions and interventions that kept coming up in my research seemed to focus almost exclusively on two areas: antenatal care (care during pregnancy for the mother) to lower the risk of preterm birth in the first place, or acute care (care within the first few weeks after birth) while in the hospital. I found this strange as something kept coming to my mind: what happens when they leave the hospital?

Although not explicitly emphasized in the literature, post-discharge complications appeared to be a significant issue. One study indicated that 98.2% of post-natal deaths occurred after discharge from hospital.[6] Case studies of similar environments have investigated predictors of mortality after discharge, identifying factors such as sepsis, pneumonia, and cot death.[7] Maternal risk factors may include poor antenatal care, age at delivery, and level of education[8], environmental risk factors may include scarcity of skilled healthcare workers, lack of infrastructure, smoke exposure, and resource restriction.[9]

[6] Brink, L. T., Gebhardt, G. S., Mason, D., Groenewald, C. A., & Odendaal, H. J. (2019). The association between preterm labour, perinatal mortality and Infant Death (during the first year) in Bishop Lavis, Cape Town, South Africa. South African Medical Journal, 109(2), 102–106. https://doi.org/10.7196/samj.2019.v109i2.13438

[7] Nsubuga, R., Rujumba, J., Nyende, S., Kisaka, S., Idro, R., & Nankunda, J. (2024). Predictors of mortality among low birth weight neonates after hospital discharge in a low-resource setting: A case study in Uganda. PLOS ONE, 19(6). https://doi.org/10.1371/journal.pone.0303454

[8] De Jesus, L. C., Pappas, A., Shankaran, S., Kendrick, D., Das, A., Higgins, R. D., Bell, E. F., Stoll, B. J., Laptook, A. R., Walsh, M. C., & Eunice Kennedy Shriver National Institute of Child Health and Human Development Neonatal Research Network (2012). Risk factors for post-neonatal intensive care unit discharge mortality among extremely low birth weight infants. The Journal of pediatrics, 161(1), 70–4.e42. https://doi.org/10.1016/j.jpeds.2011.12.038

[9] Michaelis, I. A., Krägeloh-Mann, I., Manyisane, N., Mazinu, M. C., & Jordaan, E. R. (2021). Prospective cohort study of mortality in very low birthweight infants in a single centre in the Eastern Cape province, South Africa. BMJ paediatrics open, 5(1), e000918. https://doi.org/10.1136/bmjpo-2020-000918

[10]Kleinhout, M. Y., Stevens, M. M., Osman, K. A., Adu-Bonsaffoh, K., Groenendaal, F., Biza Zepro, N., Rijken, M. J., & Browne, J. L. (2021). Evidence-based interventions to reduce mortality among preterm and low-birthweight neonates in low-income and middle-income countries: a systematic review and meta-analysis. BMJ global health, 6(2), e003618. https://doi.org/10.1136/bmjgh-2020-003618

I had discovered that home-based newborn care[10] proved an effective opportunity for intervention. Additionally, my interviews confirmed that improved education around care of preterm infants has proven effective in lowering post-discharge death rates. My interviews also confirmed that methods such as kangaroo mother care, peer-to-peer education, and community-based referrals prove effective in supporting families of preterm infants.

I kept thinking back to some of the market research I had done. Everyone was so fixated on caring for these babies in hospital, that we were not looking beyond their time in the NICU (Neonatal Intensive Care Unit).

Existing designs almost exclusively looked at designing medical equipment – designers heard the words “premature baby” and immediately decided that designing an incubator must be the best way to help.

Figure 14: NeoNurture Incubator Designed Using Car Parts

I came across one story where a group of designers were tasked with the problem of how to decrease the number of infant deaths globally. The team identified that if more babies had access to incubators, they would have a greater chance of survival. However, in developing countries, incubators are few and far between. Anyone who’s ever lived in a developing country will confirm that there is one thing that is not in short supply: scrap metal and spare car parts. And so, the team ingeniously designed an incubator that could be built and repaired using spare car parts. It was ingenious.

However, for a number of valid reasons, it was never adopted in the developing countries it was intended for. The designers had missed the mark, and however bright their solution was, their primary users didn’t want to adopt it.
I didn’t want my design to end up obsolete because I thought I was solving the problem when it was entirely different.
It felt like I had finally gotten somewhere. I had found the end of the big, knotted ball of string. Now it was time to start framing my issue.

It felt like I had finally gotten somewhere. I had found the end of the big, knotted ball of string. Now it was time to start framing my issue.

3

Structuring the Problem

- Mind Mapping the Problem: Breaking down neonatal care challenges
- Spyder Diagrams: Causes and effects
- Cause effect loops: Identifying reinforcing and balancing patterns
- Environmental Mapping: Stakeholders and the Macro Environment

Chapter 3

Structuring the Problem

Structuring the problem entails breaking the main problem into smaller, more manageable problems.

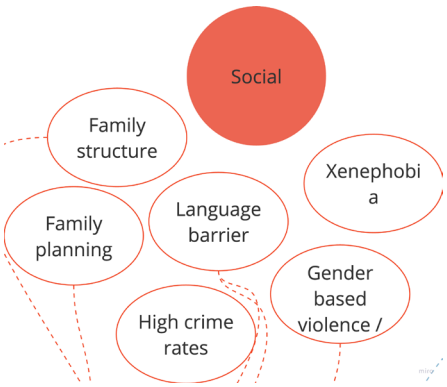
We do this without losing sight of how each of these problems are connected to one another. Tools used in this part of the process include:

- Mind maps
- Spyder diagrams
- Cause effect loops
- Environmental mapping

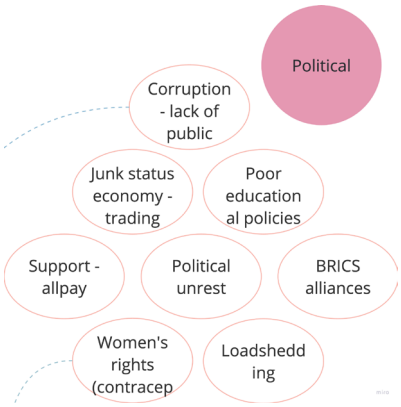
Mind Mapping the Problem: Breaking Down Neonatal Care Challenges

The mindmap visually dissects “Poor outcomes post discharge” into interconnected social, political, environmental, economic, cultural, and healthcare system factors. This structure is invaluable in systems design as it immediately reveals the intricate web of influences at play.

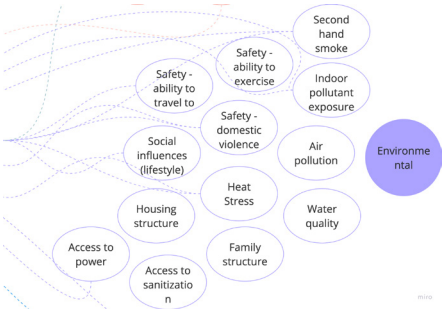
Figure 15: Mind Map



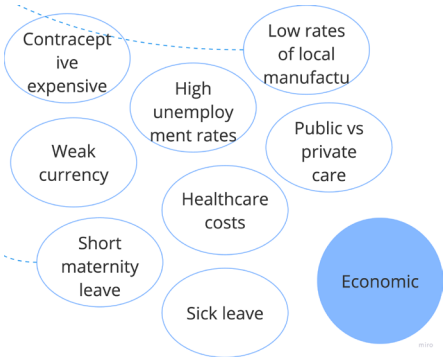
Social:
Includes factors like family structure, social influences (lifestyle), language barriers, gender-based violence, xenophobia, and high crime rates.



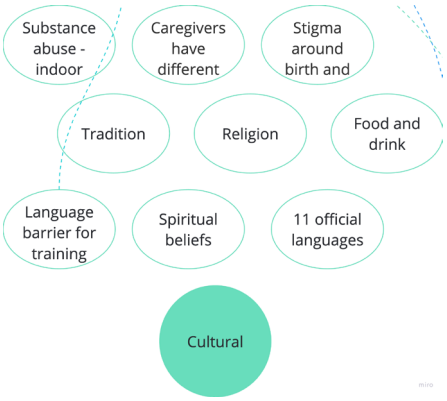
Political:
Covers political unrest, corruption, poor education policies, “junk status” economy trading, BRICS alliances, women’s rights, and loadshedding (power outages).



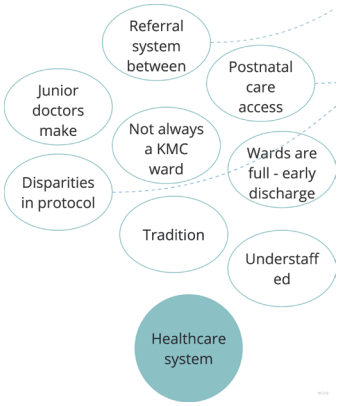
Environmental:
Features air pollution, indoor pollutant exposure, second-hand smoke, water quality, and heat stress.



Economic:
Highlights weak currency, healthcare costs, short maternity leave, sick leave, high unemployment rates, and public vs. private care.



Cultural:
Encompasses tradition, religion, spiritual beliefs, substance abuse, caregiver differences, stigma around birth, food and drink, and 11 official languages.



Healthcare System:
Includes understaffing, disparities in protocol, junior doctors making decisions, lack of Kangaroo Mother Care (KMC) wards, early discharge, postnatal care access, referral system issues, equipment costs, technology and innovation gaps, and sanitation access.

All of these factors cause poor health outcomes post-discharge for premature babies. The lines connecting the nodes highlight the interdependencies between different factors. For example, “Poor education policies” (political) can contribute to “High unemployment rates” (economic), which in turn can exacerbate “Malnourishment” (social). Recognizing these connections is crucial for developing holistic solutions.

Spyder Diagrams: Causes and Effects

Spyder diagrams are a useful tool for visualizing different causes and effects for a particular outcome.
In this case, I was able to visualize my research to plot the vast causes and intricate effects of poor health outcomes post-discharge.

The “Causes” branch reveals a multi-layered system: Maternal Factors (age, health conditions, lifestyle), Socioeconomic Factors (education, violence, stress), Environmental Factors (physical labor), Medical Interventions (cervical issues, uterine abnormalities), and Infant Risk Factors (low birth weight, prolonged stay, etc.).
These highlight how a preterm infant’s health is influenced by a confluence of medical, social, and environmental circumstances.

Figure 16: Spyder Diagram - Causes

Figure 17: Spyder Diagram - Effects

The “Effects” branch demonstrates the cascading consequences of poor outcomes, impacting the infant (long-term developmental delays, neurological problems), healthcare systems (increased demand, poor growth monitoring), and families (financial strain, educational challenges). This illustrates the system’s ripple effect, where initial health issues lead to broader societal and personal burdens.

Cause-Effect Loops: Identifying Reinforcing and Balancing patterns

Cause and effect loops help us to identify what we can refer to as “vicious cycles” within a problem. We start by writing down the words/entities in a cycle of events, and then allocate plusses and minus between words. Plusses mean that there is a reinforcing (additive) effect, while minuses mean there is a balancing (negative) effect. We then look at the loop as a whole and see whether the overall cause-effect loop is reinforcing, or balancing.

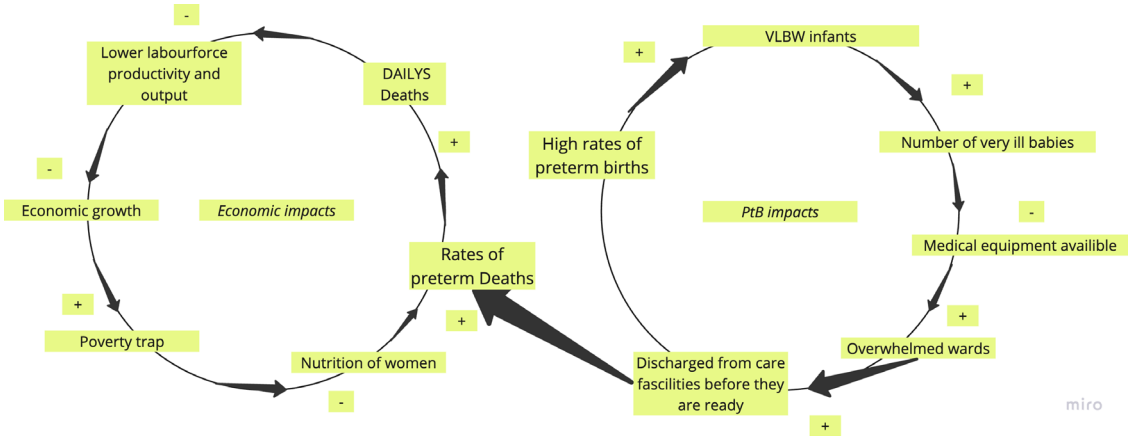


Figure 18: Cause Effect Loop Relating Preterm Birth and Economic Impacts of High Death Rates Post Discharge

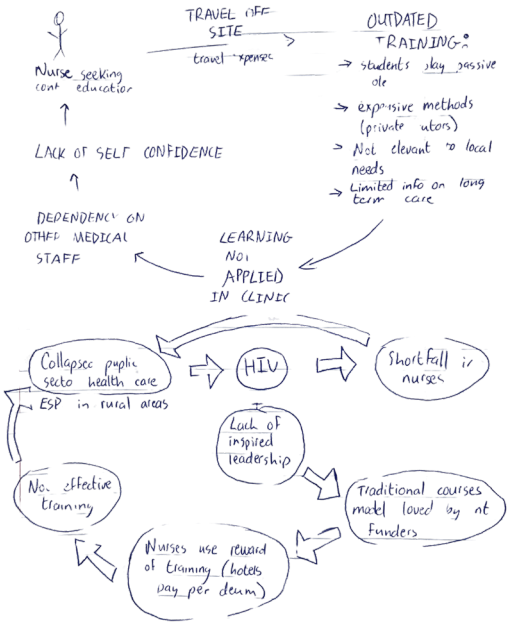


Figure 19: Feedback Loop Notes from Literature Review- Challenges in Healthcare Provider Training

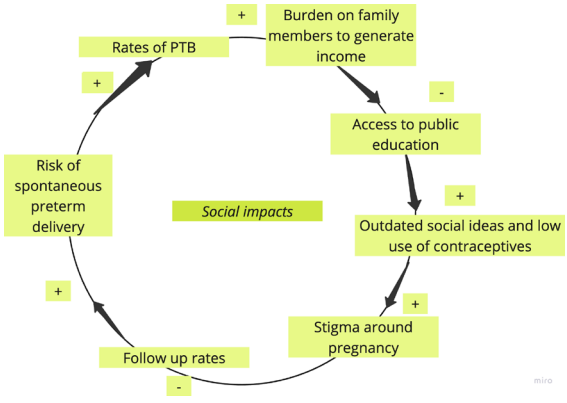


Figure 20: Reinforcing Feedback Loop - the Social Impacts of Preterm Birth

Environmental Mapping: Stakeholders and the Macro Environment

Stakeholder mapping allows us to map the different entities involved in a problem scope, and to highlight their level of involvement. When it comes to premature babies, we can split stakeholders into three key levels of involvement: core, involved, and informed. This helps highlight who we can target with our design, and at which level.

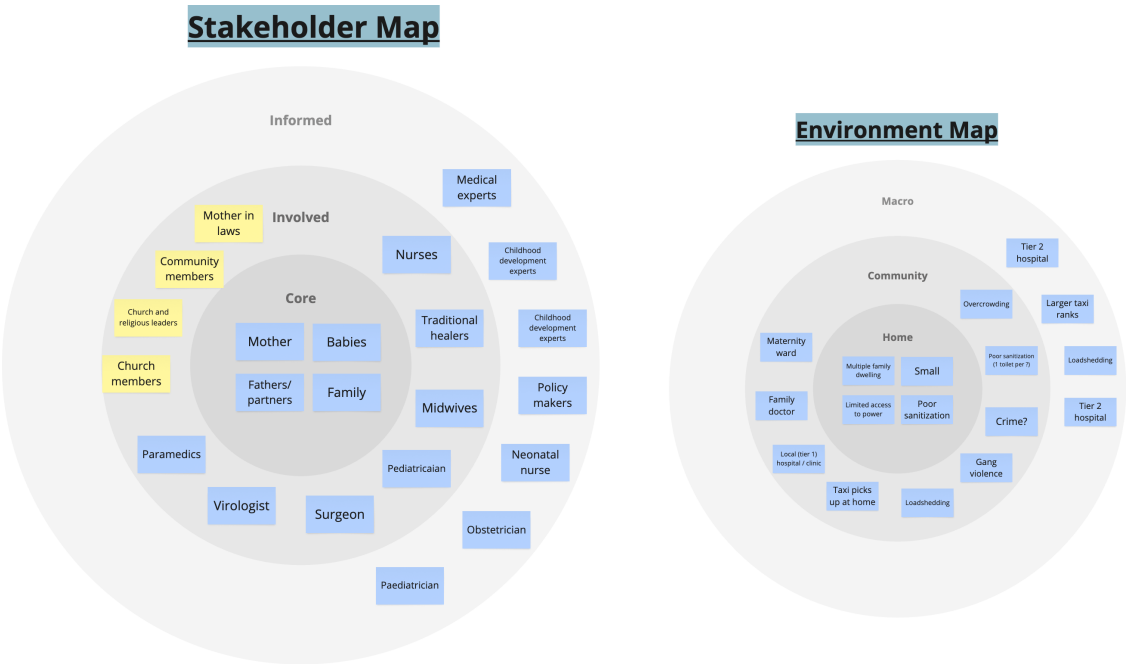
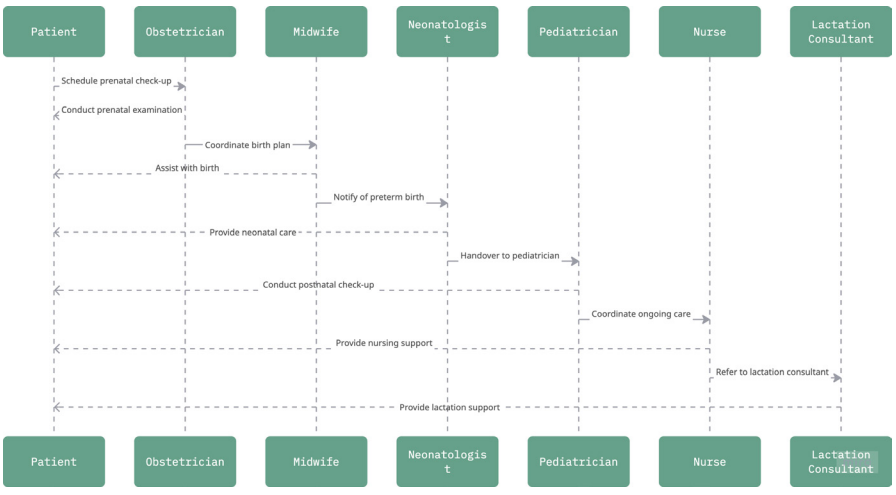


Figure 21: Stakeholder and Environmental Mapping



This flow map outlines the sequential interactions between healthcare stakeholders - patient, obstetrician, midwife, neonatologist, pediatrician, nurse, and lactation consultant - during prenatal, birth, and postnatal care. It highlights the coordinated roles and handoffs in the patient's journey, emphasizing the interconnectedness of care.

Figure 22: Flow Map Highlighting Relationships Between Entities

Lastly, it is important to understand the macro and micro environmental factors at play. This map illustrates the complex stakeholder ecosystem surrounding preterm infants and mothers, categorized by their level of involvement (Core, Supporters, Involved, Informed). It highlights the interplay between these stakeholders and critical environmental factors like poor socio-economic conditions, government corruption, lack of infrastructure investment, and limited public education. The map underscores the systemic challenges impacting maternal and infant health, emphasizing the need for collaborative solutions across various sectors.

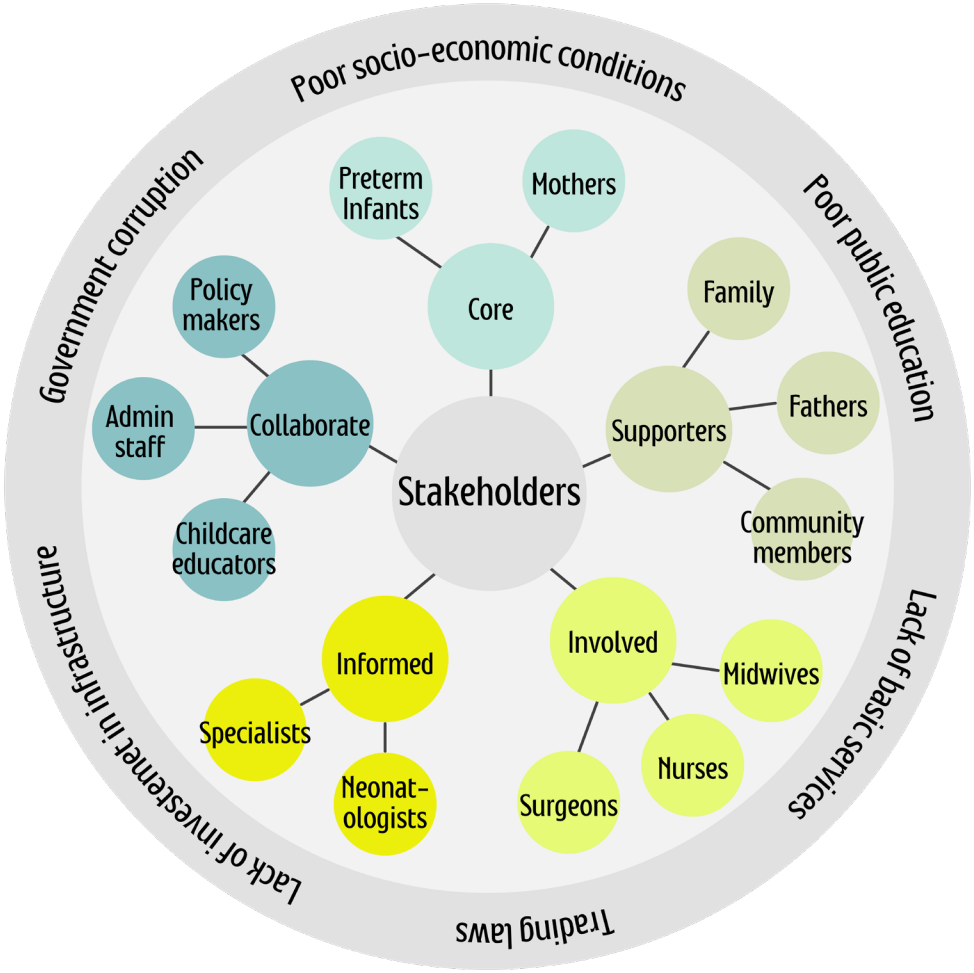


Figure 23: Environmental and Stakeholder Entity Map

Key takeaways from this exercise were that families of premature babies are often multigenerational, living in single-family homes, informal dwellings, and remote locations. Lastly, they are an incredibly resilient community.

4

Understand and Intervene the System

> Fishbone Diagrams: Finding the Root Causes
> Fishbone Diagrams: Identifying
> Possible Interventions

Chapter 4

Understand and Intervene the System

Understanding and intervening the system entails looking at the root causes of a problem, and then suggesting solutions for each one.

In order to do this, I used the fishbone diagram method: I identified a series of problems that contribute to the overall problem. In the case of poor health outcomes for premature babies, we have the following categories of causes/problems:

- Policy and governance factors
- Healthcare system factors
- Socioeconomic factors
- Infant biological factors
- Parental/ caregiver factors
- Environmental factors (community)
- Environmental factors (within home)

Figure 24: Fishbone Map of Problems Related to High Infant Mortality Post-Discharge

We then take these problems, and each one becomes its own "fish head." Each fishbone becomes it's own sub-problem of the main problem. We then plot more sub-problems, eventually breaking up the problem's problem's into problems. I know this sounds like a lot, but hang in there with me.

Fishbone Diagrams: Finding the Root Causes

I created four fishbone diagrams for the following categories of problems that contribute to high death rates post-discharge:

- Home environment
- Community environment
- Healthcare system issues
- Infant risk factors

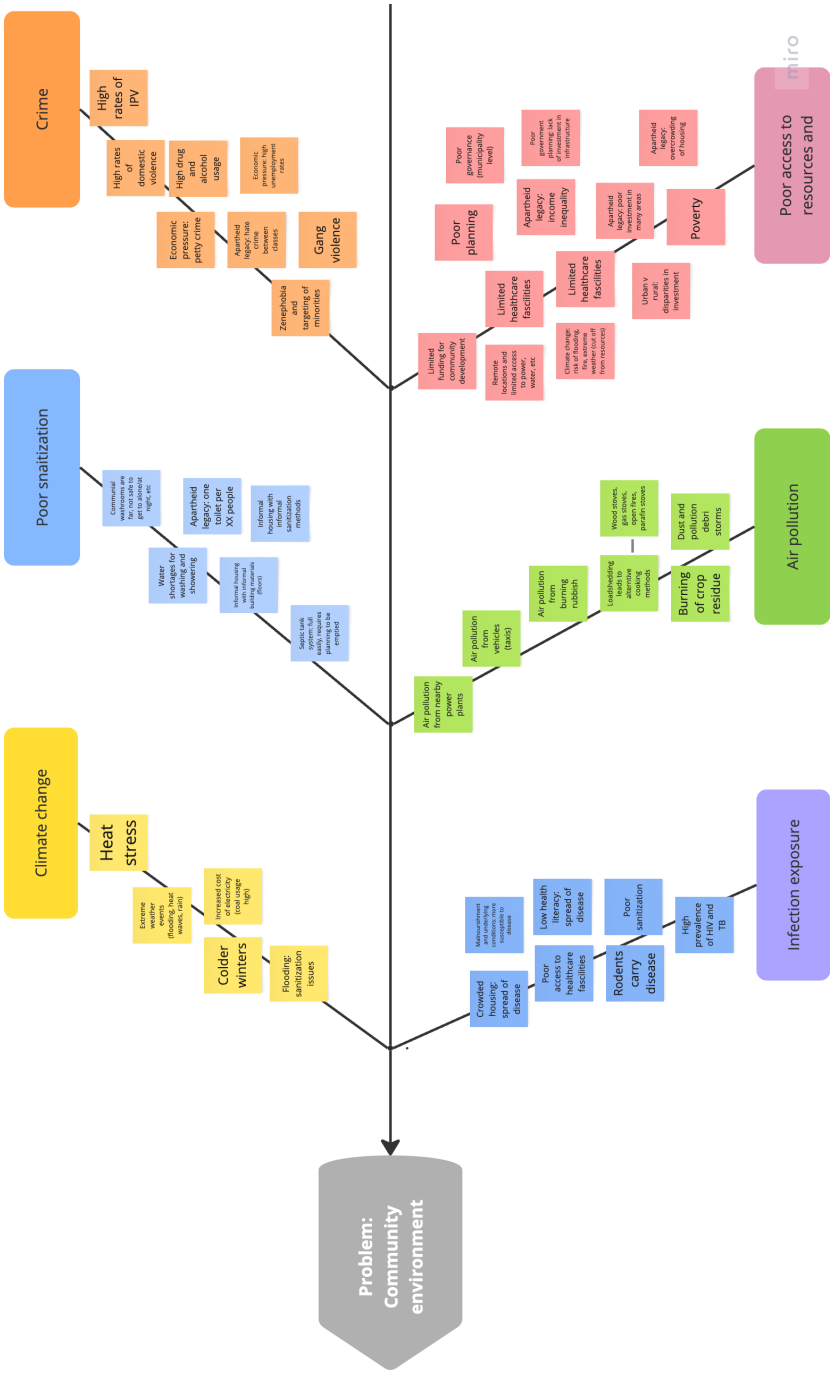


Figure 25: Fishbone Map of the Community Environment to Which Families are Discharged

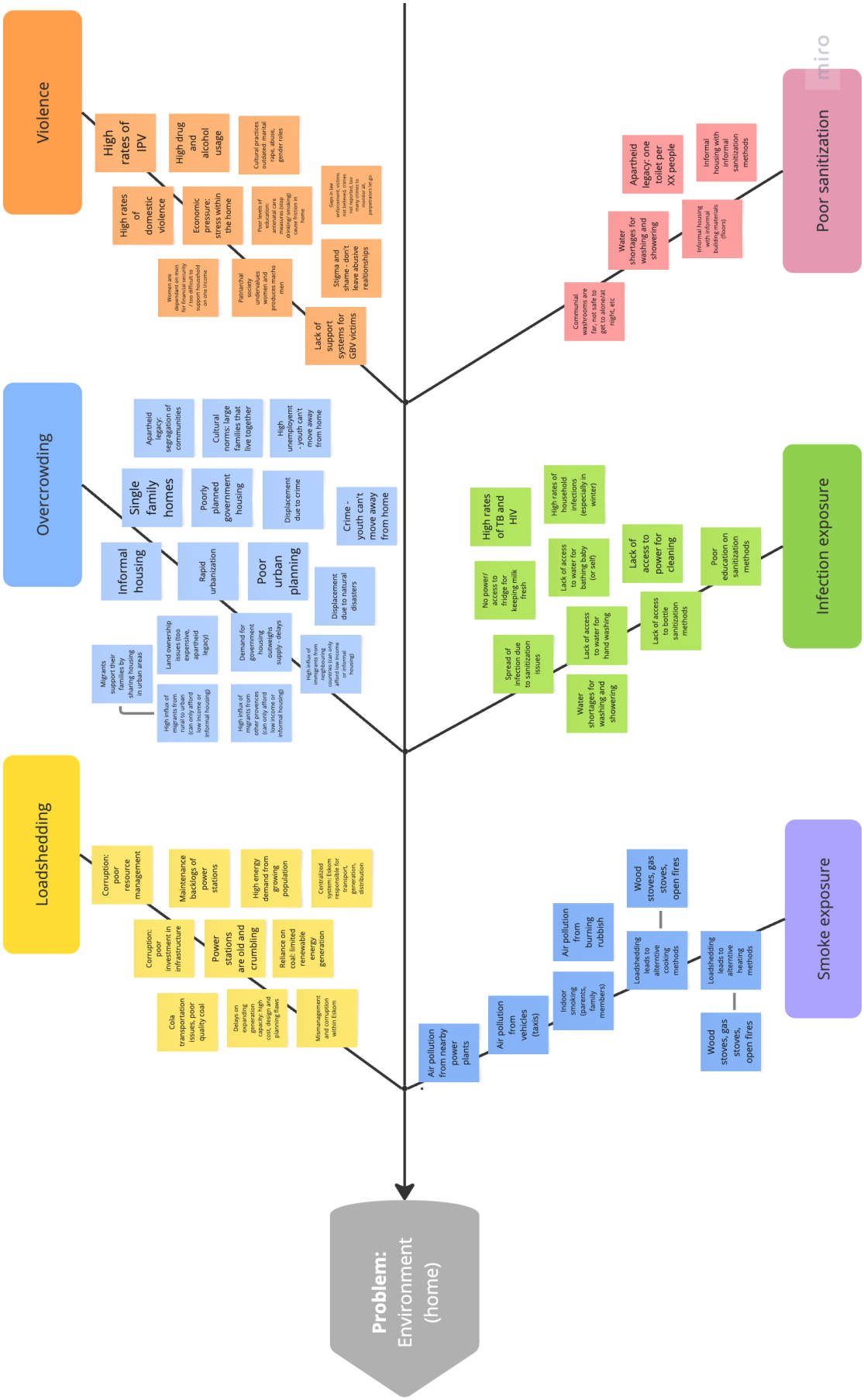


Figure 26: Fishbone Map of the Home Environment to Which Families are Discharged

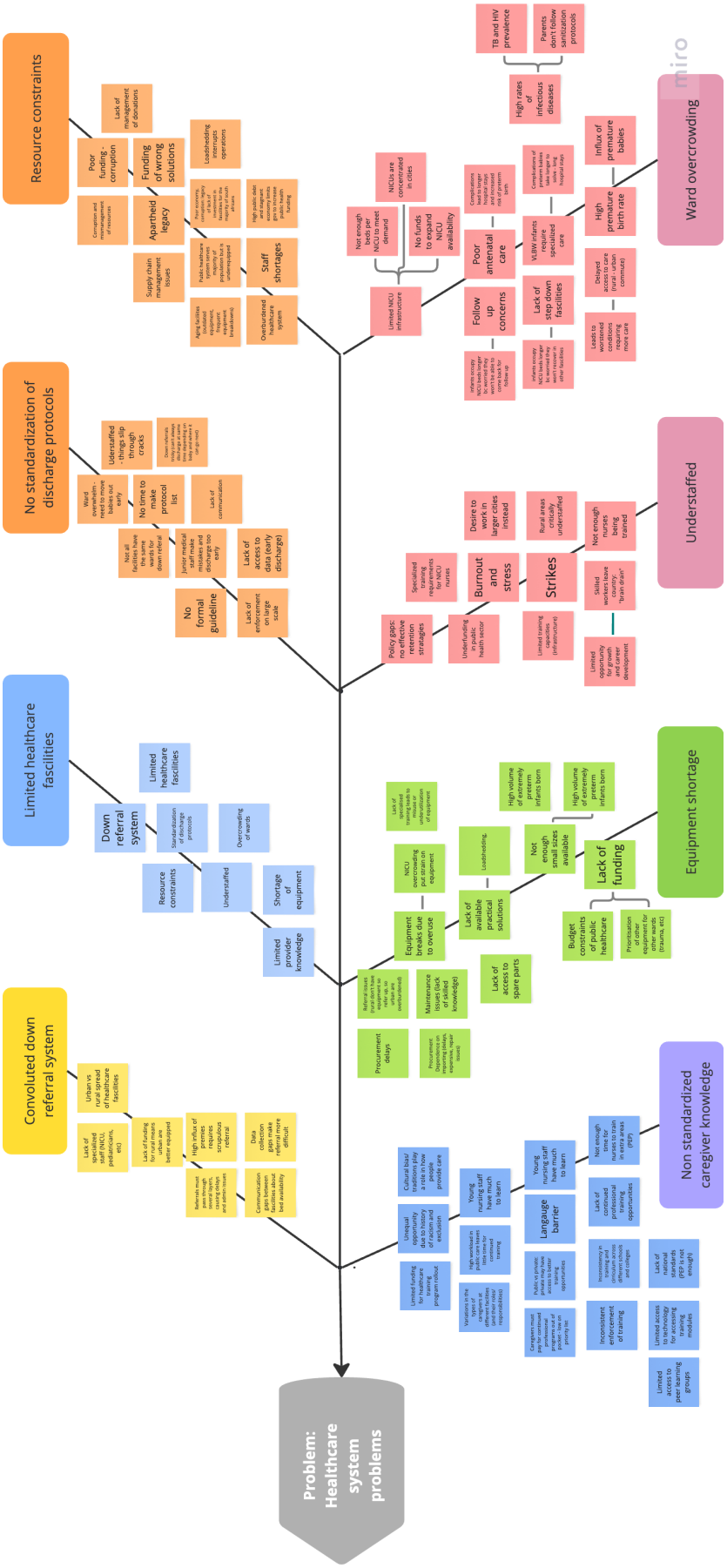


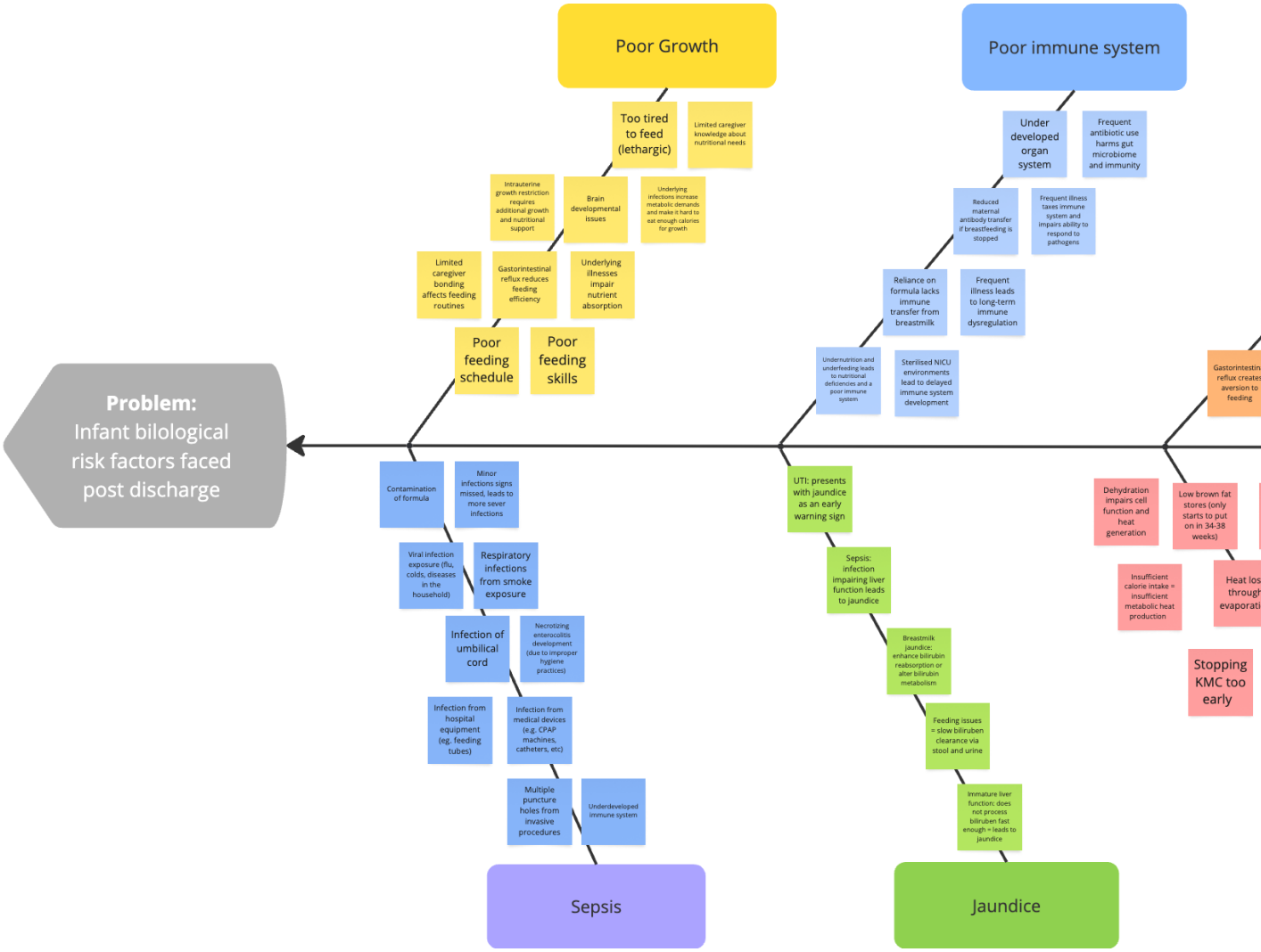
Figure 27: Fishbone Map of Problems in the South African Healthcare System

Let us take the infant biological risk factor fishbone (Fig 25) as an example. Branching off from this central spine are eleven main categories, each representing a potential cause of poor health outcomes for premature infants after discharge:

- Poor Growth
- Poor Immune System
- Poor Feeding
- Poor Sleep
- Poor Neurological Development
- Sepsis
- Hypothermia
- Hypoglycemia

Under each of these categories, I mapped out the potential causes for such a problem. For example, poor feeding may be because of delayed hunger cues, underlying illnesses reducing feeding abilities, latching issues, the baby being too tired to feed, etc.

I moved through each bone of each fishbone diagram until I had all of the causes of each contributing factor mapped out (Figures 29 - 33)



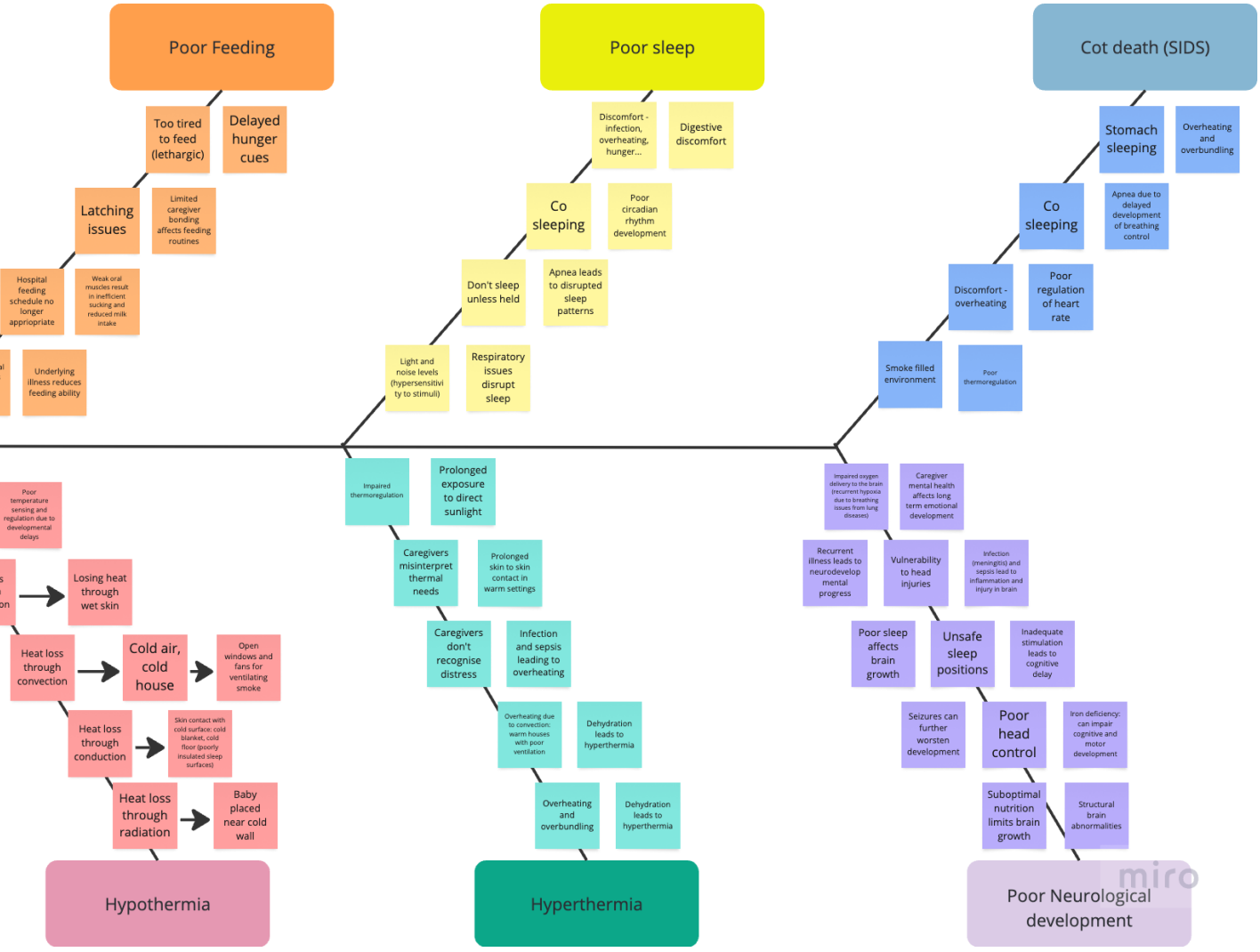


Figure 28: Fishbone Map of Biological Risk Factors Faced by Infants Post-Discharge

Fishbone Diagrams: Identifying Possible Interventions

I then moved on to mapping solutions to these problems. Again, let's take the problem of poor feeding:

- Delayed hunger cues can be solved by teaching parents cue recognition and hunger recognition
- Underlying illnesses reducing feeding abilities can be solved by identifying possible underlying causes and illness and treating them

Latching issues can be solved by encouraging parents to bring their bottles to the NICU for training, and providing training on breastfeeding practices

- Baby being too tired to feed can be solved by address possible underlying conditions that cause lethargy in the baby

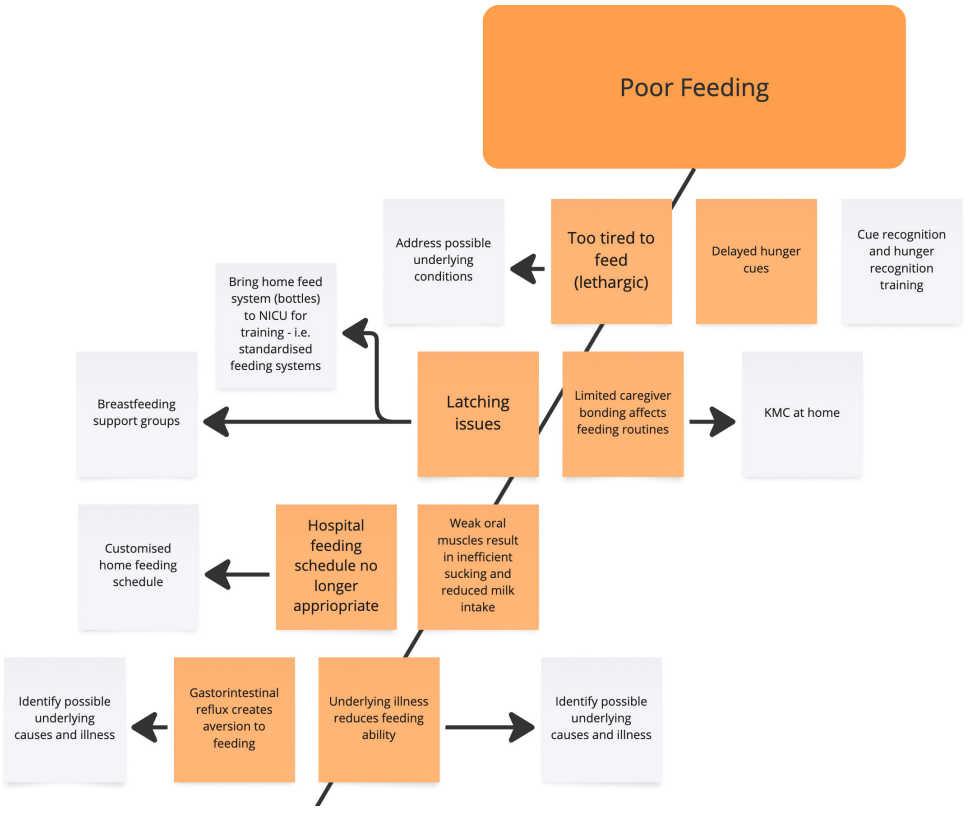


Figure 29: Fishbone Interventions Map for Poor Feeding

I continued this process for the remaining fishbone diagrams, until I had over a hundred solutions, all contributing to preventing poor health outcomes for premature babies post discharge.

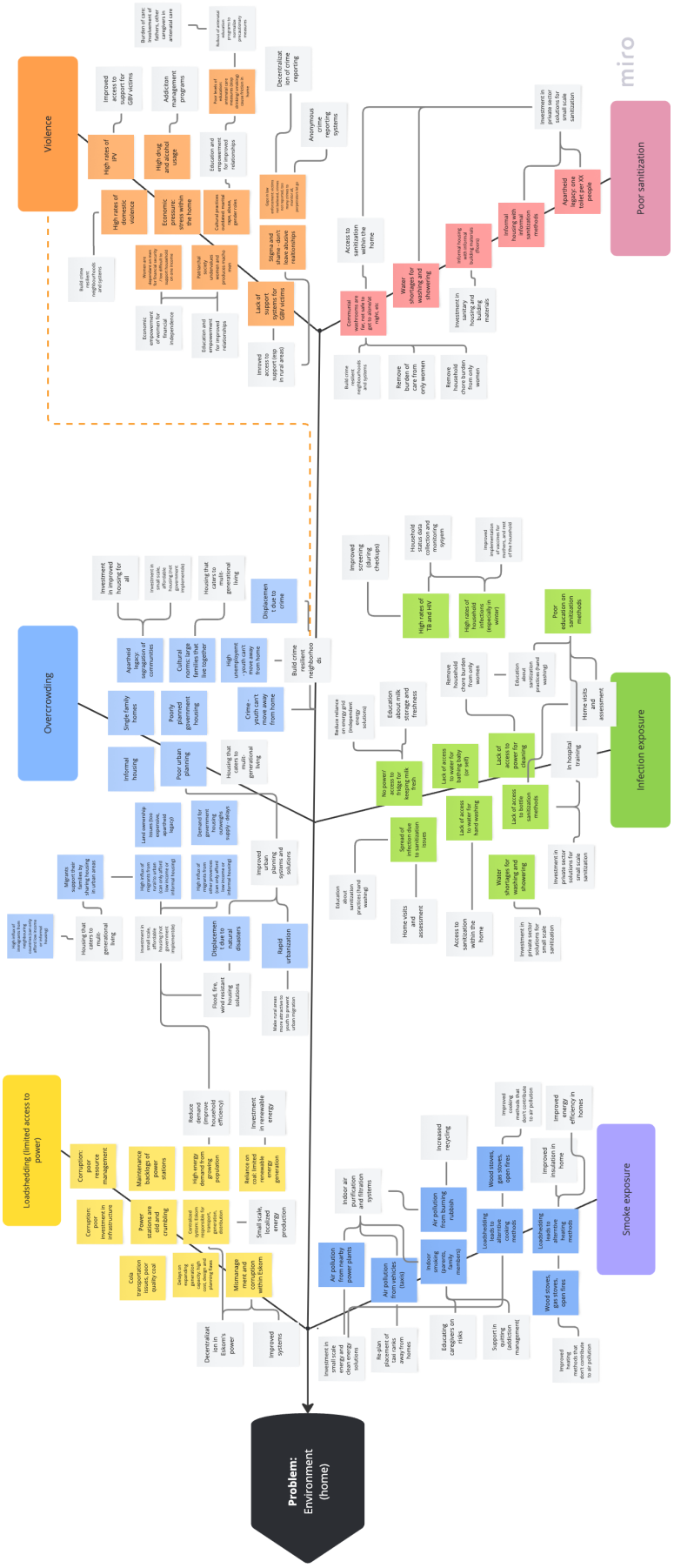
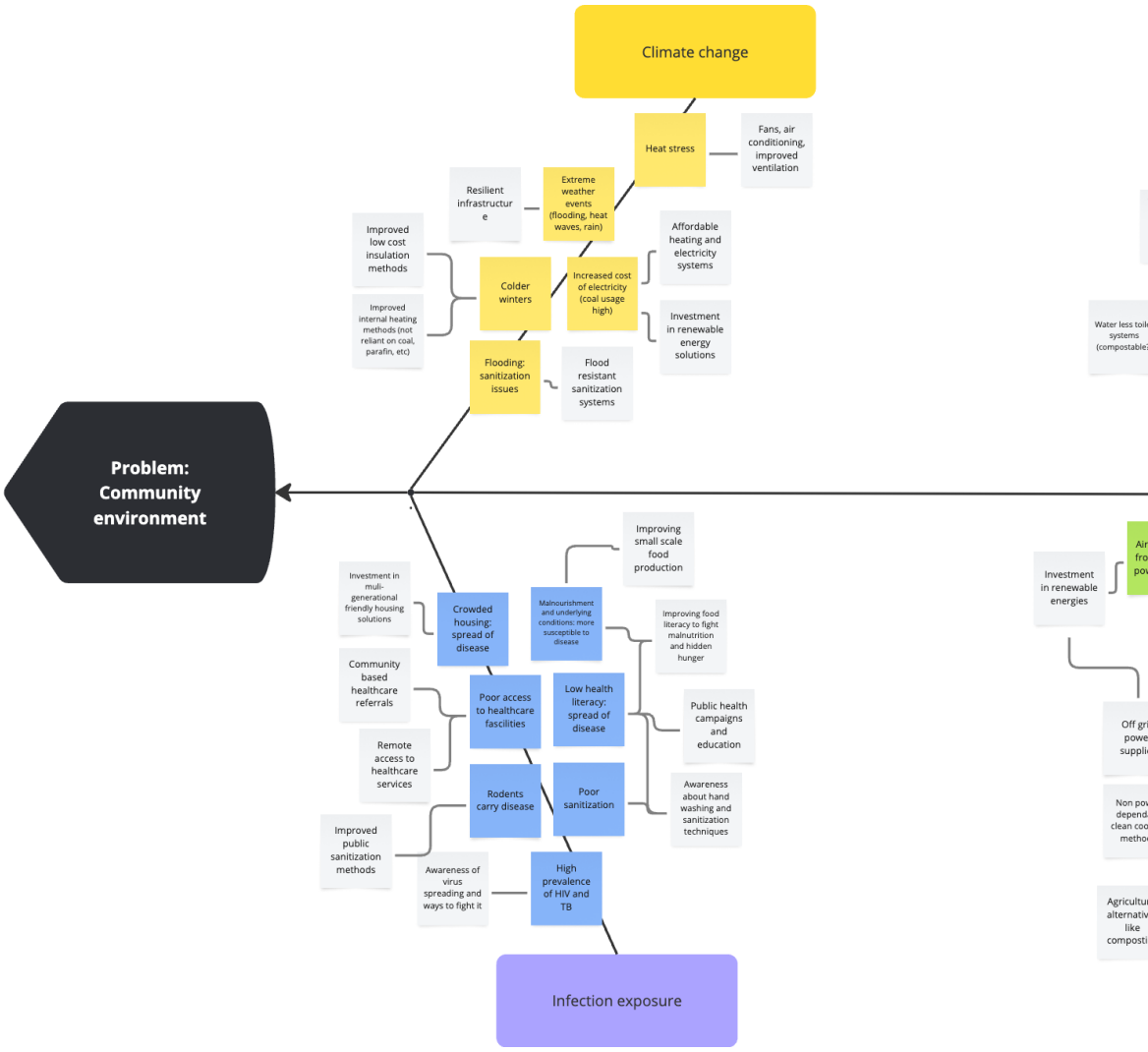


Figure 30: Fishbone Interventions Map for the Home Environment to Which Families are Discharged


Climate change
Heat stress
Fans, air conditioning, improved ventilation
Resilient infrastructur e
Extreme weather events (flooding, heat waves, rain)
Improved low cost insulation methods
Affordable heating and electricity systems
Colder winters
Increased cost of electricity (coal usage high)
Improved internal heating methods (not reliant on coal, parafin, etc)
Investment in renewable energy solutions
Flooding: sanitization issues
Flood resistant sanitization systems
Problem: Community environment
Improving small scale food production
Investment in muli-generational friendly housing solutions
Crowded housing: spread of disease
Malnourishment and underlying conditions: more susceptible to disease
Improving food literacy to fight malnutrition and hidden hunger
Community based healthcare referrals
Poor access to healthcare fascilities
Low health literacy: spread of disease
Public health campaigns and education
Remote access to healthcare services
Rodents carry disease
Poor sanitization
Awareness about hand washing and sanitization techniques
Improved public sanitization methods
Awareness of virus spreading and ways to fight it
High prevalence of HIV and TB
Infection exposure
Investment in renewable energies

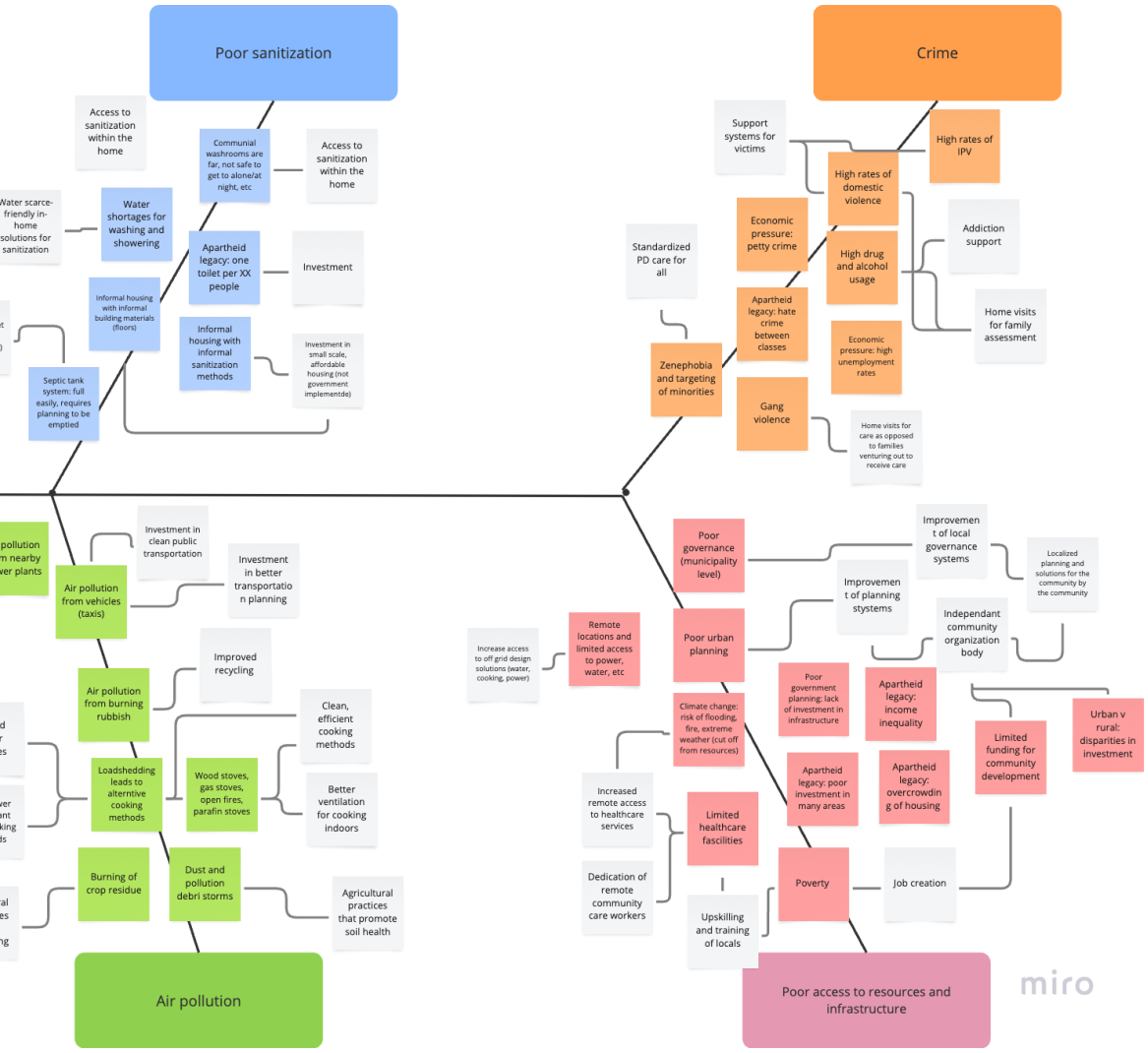
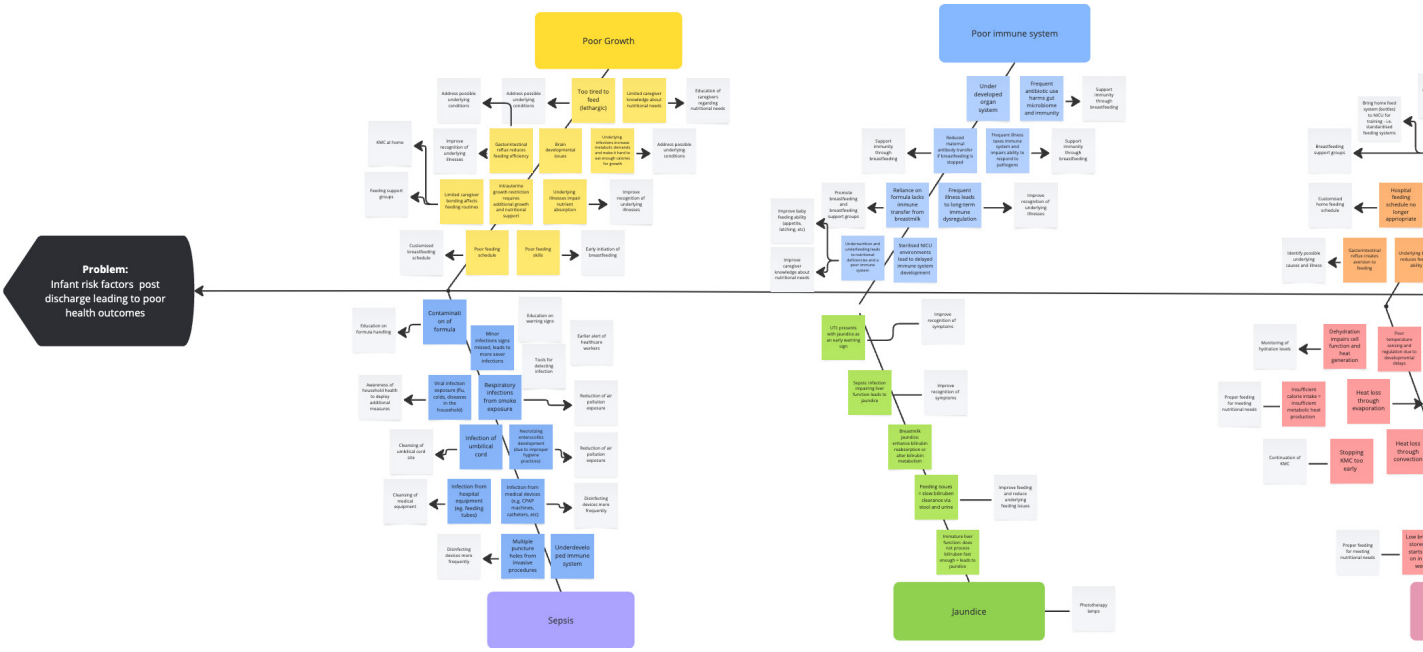


Figure 31: Fishbone Interventions Map for the Community Environment to Which Families are Discharged


Problem:
Infant risk factors post discharge leading to poor health outcomes
Poor Growth
Too tired to feed (lethargic)
Poor feeding schedule
Poor feeding skills
Contamination of formula
Respiratory infections from smoke exposure
Infection of umbilical cord
Underdeveloped immune system
Sepsis
Poor immune system
Under developed organ system
Reliance on formula lacks immune transfer from breastmilk
Frequent illness leads to long-term immune dysregulation
Jaundice
Dehydration impairs cell function and heat generation
Heat loss through evaporation
Stopping KMC too early

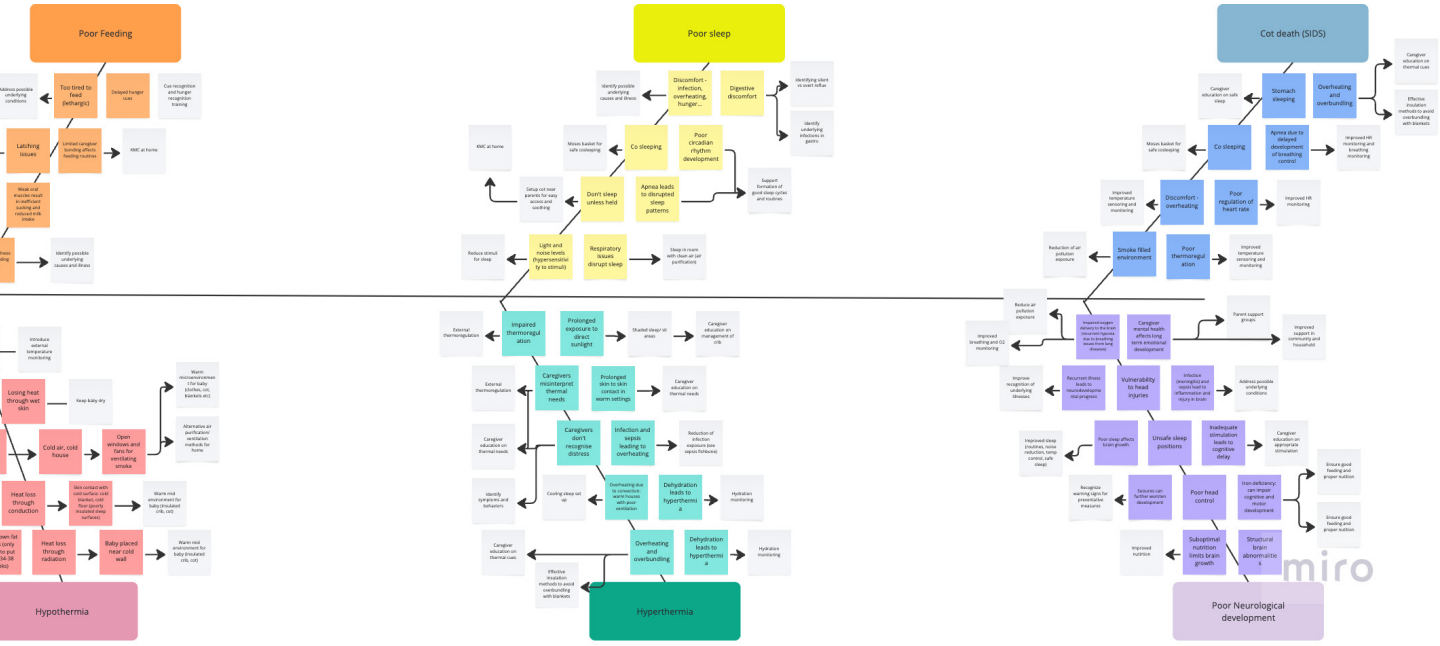
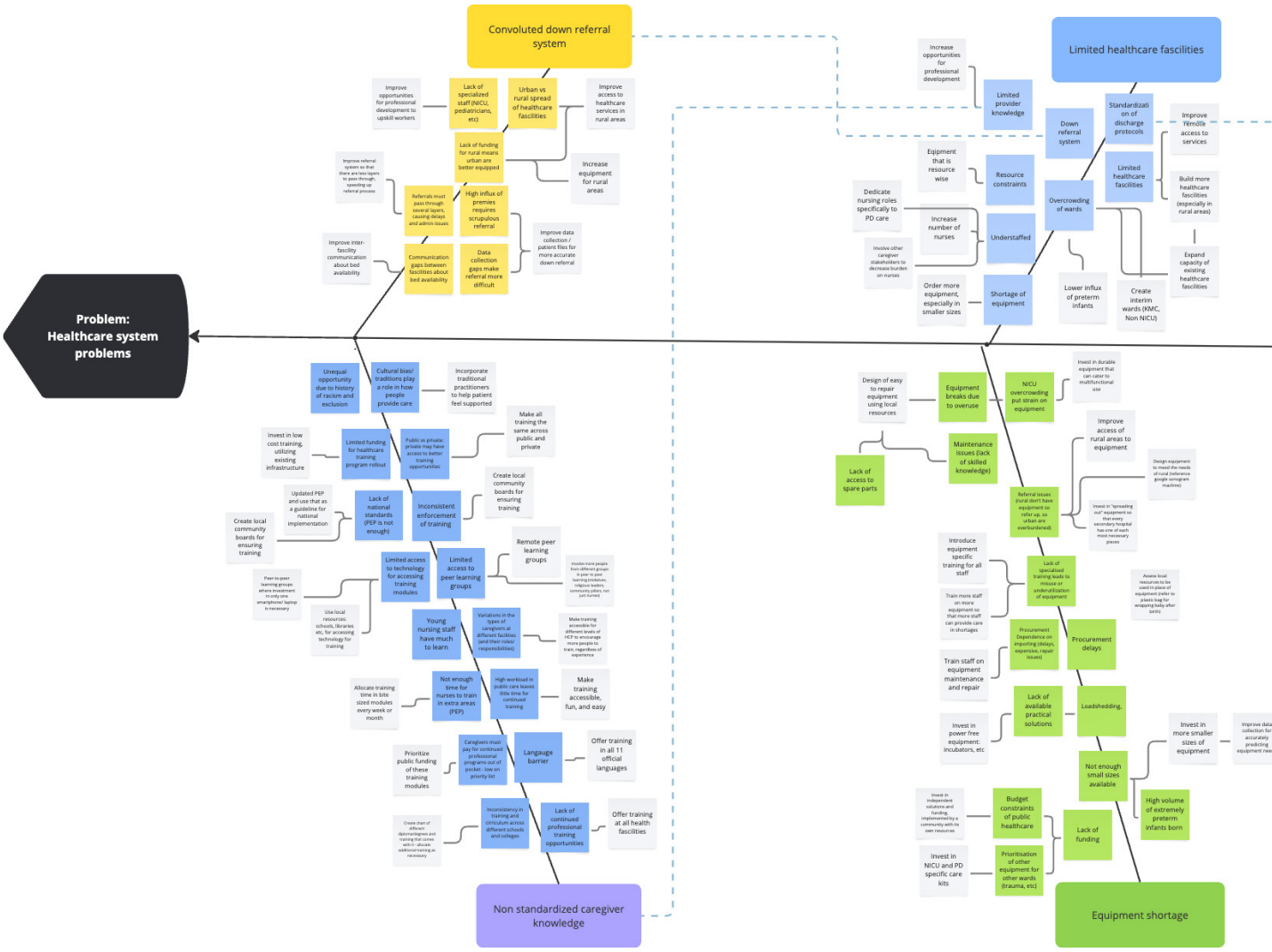


Figure 32: Fishbone Interventions Map for Biological Risk Factors Faced by Infants Post-Discharge


Problem: Healthcare system problems
Convoluted down referral system
Improve opportunities for professional development to upskill workers
Lack of specialized staff (NICU, pediatricians, etc)
Urban vs rural spread of healthcare fascilities
Improve access to healthcare services in rural areas
Lack of funding for rural means urban are better equipped
Increase equipment for rural areas
Improve referral system so that there are less layers to pass through, speeding up referral process
Referrals must pass through several layers, causing delays and admin issues
High influx of premies requires scrupulous referral
Improve data collection / patient files for more accurate down referral
Improve inter-facility communication about bed availability
Communication gaps between facilities about bed availability
Data collection gaps make referral more difficult
Limited healthcare fascilities
Increase opportunities for professional development
Limited provider knowledge
Down referral system
Standardization of discharge protocols
Improve financial access to services
Eqipment that is resource wise
Resource constraints
Limited healthcare fascilities
Build more healthcare facilities (especially in rural areas)
Dedicate nursing roles specifically to PD care
Increase number of nurses
Understaffed
Overcrowding of wards
Expand capacity of existing healthcare fascilities
Involve other caregiver stakeholders to decrease burden on nurses
Order more equipment, especially in smaller sizes
Shortage of equipment
Lower influx of preterm infants
Create interim wards (NMC, Non NICU)
Unequal opportunity due to history of racism and exclusion
Cultural bias/ traditions play a role in how people provide care
Incorporate traditional practitioners to help patient feel supported
Invest in low cost training, utilizing existing infrastructure
Limited funding for healthcare training program rollout
Public vs private: private may have access to better training opportunities
Make all training the same across public and private
Updated PEP and use that as a guideline for national implementation
Lack of national standards (PEP is not enough)
Inconsistent enforcement of training
Create local community boards for ensuring training
Create local community boards for ensuring training
Remote peer learning groups
Limited access to technology for accessing training modules
Limited access to peer learning groups
Peer-to-peer learning groups where investment in only one smartphone/ laptop is necessary
Use local resources: schools, libraries etc, for accessing technology for training
Young nursing staff have much to learn
Variations in the types of caregivers at different facilities (and their roles/ responsibilities)
Make training accessible for different levels of HCP to encourage more people to train, regardless of experience
Allocate training time in bite sized modules every week or month
Not enough time for nurses to train in extra areas (PEP)
High workload in public care leaves little time for continued training
Make training accessible, fun, and easy
Prioritize public funding of these training modules
Caregivers must pay for continued professional programs out of pocket - low on priority list
Langauge barrier
Offer training in all 11 official languages
Create chart of different diplomas/degrees and training that comes with it - allocate additional training as necessary
Inconsistency in training and circulum across different schools and colleges
Lack of continued professional training opportunities
Offer training at all health fascilities
Non standardized caregiver knowledge
Design of easy to repair equipment using local resources
Equipment breaks due to overuse
NICU overcrowding put strain on equipment
Invest in durable equipment that can cater to multifunctional use
Lack of access to spare parts
Maintenance issues (lack of skilled knowledge)
Improve access of rural areas to equipment
Design equipment to meet the needs of rural (reference google sonogram machine)
Referral issues (rural don't have equipment so refer up, so urban are overburdened)
Invest in "spreading out" equipment so that every secondary hospital has one of each most necessary pieces
Introduce equipment specific training for all staff
Lack of specialised training leads to misuse or underutilization of equipment
Assess local resources to be used in place of equipment (refer to plastic bag for wrapping baby after birth)
Train more staff on more equipment so that more staff can provide care in shortages
Procurement Dependence on importing (delays, expensive, repair issues)
Procurement delays
Train staff on equipment maintenance and repair
Lack of available practical solutions
Loadshedding
Invest in power free equipment: incubators, etc
Not enough small sizes available
Invest in more smaller sizes of equipment
Improve data collection for accurately predicting equipment nee
Invest in independent solutions and funding, implementation by a community with its own resources
Budget constraints of public healthcare
Lack of funding
High volume of extremely preterm infants born
Invest in NICU and PD specific care kits
Prioritisation of other equipment for other wards (trauma, etc)
Equipment shortage

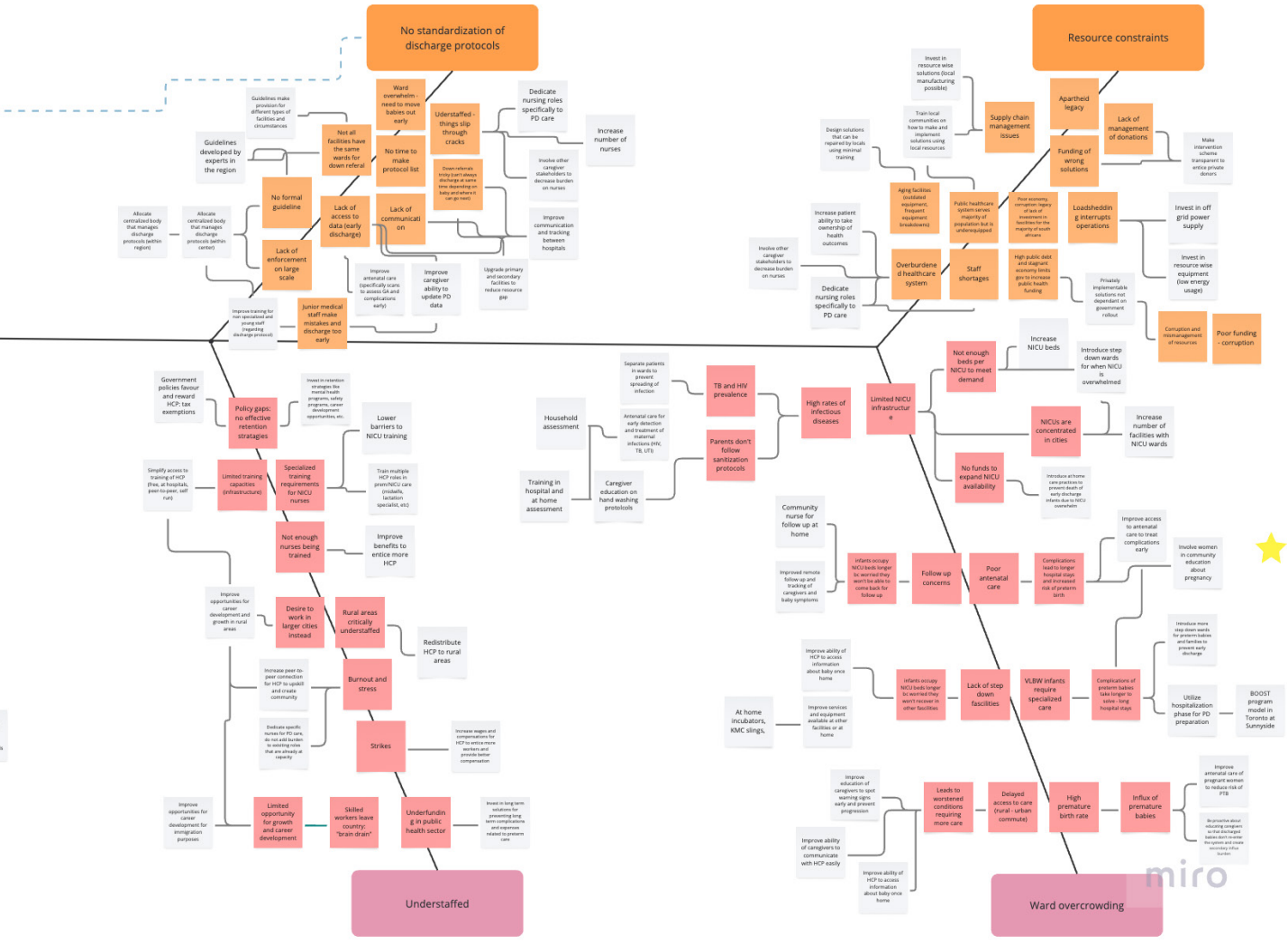


Figure 33: Fishbone Interventions Map for Problems in the South African Healthcare System

5

Creativity and Creating Certainty

- Iceberg Mapping: Plotting interventions on a scale of impact
- Leverage Wheels: Identifying the most effective interventions
- Bringing it all together: Design Conclusion and Hierarchy

Chapter 5

Creativity and Creating Certainty

Now that I had broken down the problem into smaller problems and their associated solutions, it was time to assess which of these solutions would have the deepest impact. This is where we introduce iceberg mapping.

In the words of my professor, Dr. Victor Martinez, “Complex problems don’t have silver-bullet solutions, they are solved by multiple small interventions that complement each other. That is the goal of this step, finding how our interventions connect and complement, what is within our reach or out of it, and what value or success means for each entity”

Iceberg Mapping: Plotting Interventions on a Scale of Impact

We can use an iceberg map to plot our solution on a scale of impact. The iceberg is split into 12 levels, spanning four broad categories: Events, Patterns, Structures, and Mental Models.

Level 12 (numbers) is the least effective or most superficial level of interventions. As we move down the iceberg, the interventions grow in their potential to transform the systemic problem at hand. Level 1 (transcend paradigms) is the most profound, as they alter the foundational ways people think and act.

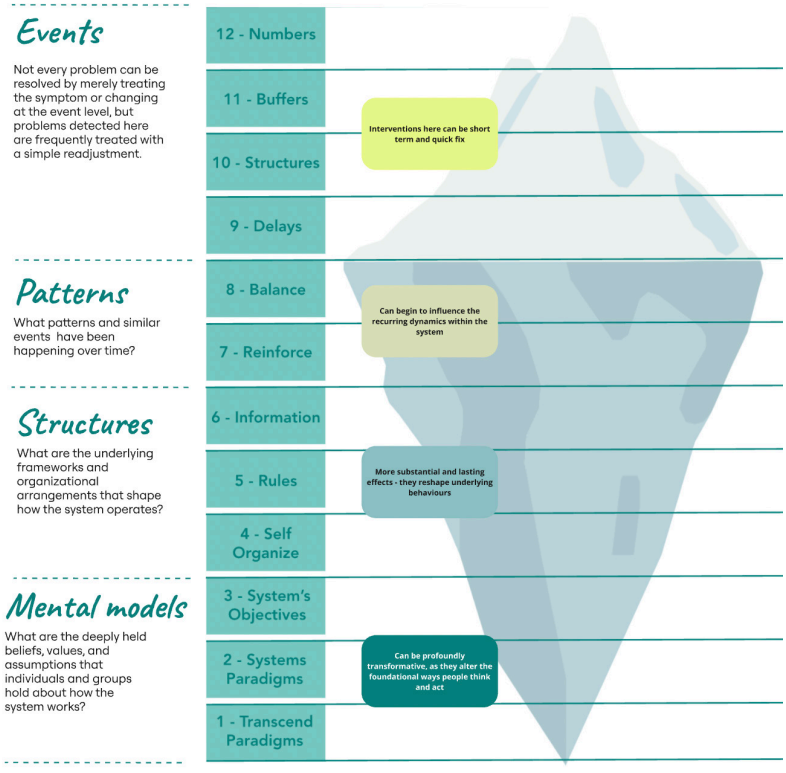


Figure 34: Iceberg Levels

I started by taking each of my interventions (solutions) from each of my fishbone diagrams and started mapping them onto the iceberg by varying levels. Many of the interventions spanned several levels, making their potential for impact vast. I found that the iceberg levels with the most solutions to be 10 (structures), 6 (information), 5 (rules), 4 (self-organize), and 3 (systems objectives).

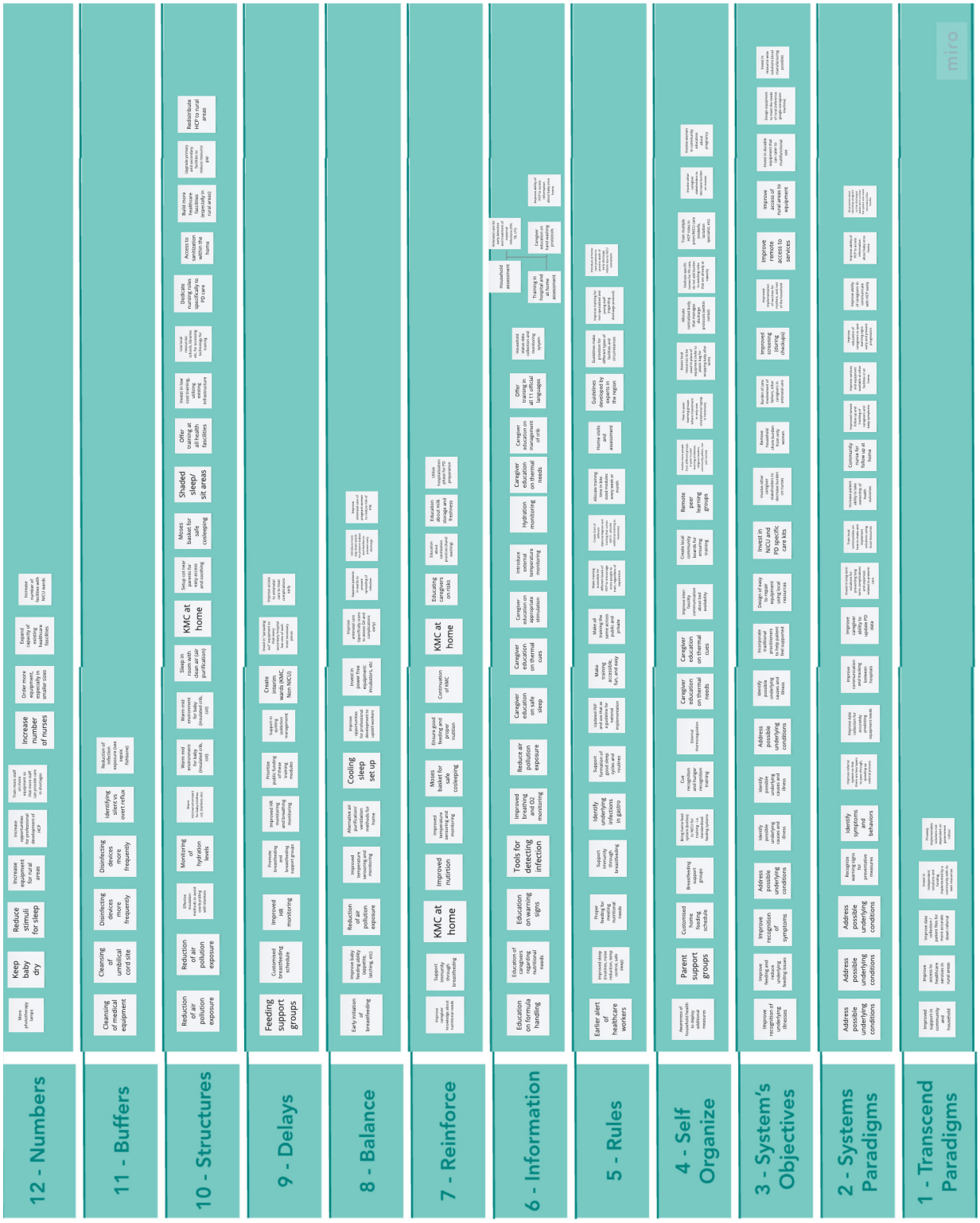


Figure 35: Iceberg Levels With Interventions

Leverage Wheels: Identifying the Most Effective Interventions

I then moved onto the leverage wheel - a tool that maps the levels of the iceberg on a wheel, allowing us to draw connecting lines between solutions to see which ones are the most interconnected across a spread of effectiveness.
Here, it became clear that the most effective solutions from lower levels such as level 2 (system paradigms) connected with solutions across all levels of the iceberg.

Themes that emerged were addressing possible underlying health conditions, improving caregiver ability to update health data post discharge, recognizing warning signs for preventative measures, identifying symptoms and behaviors, and improving caregiver ability to connect with healthcare providers remotely.

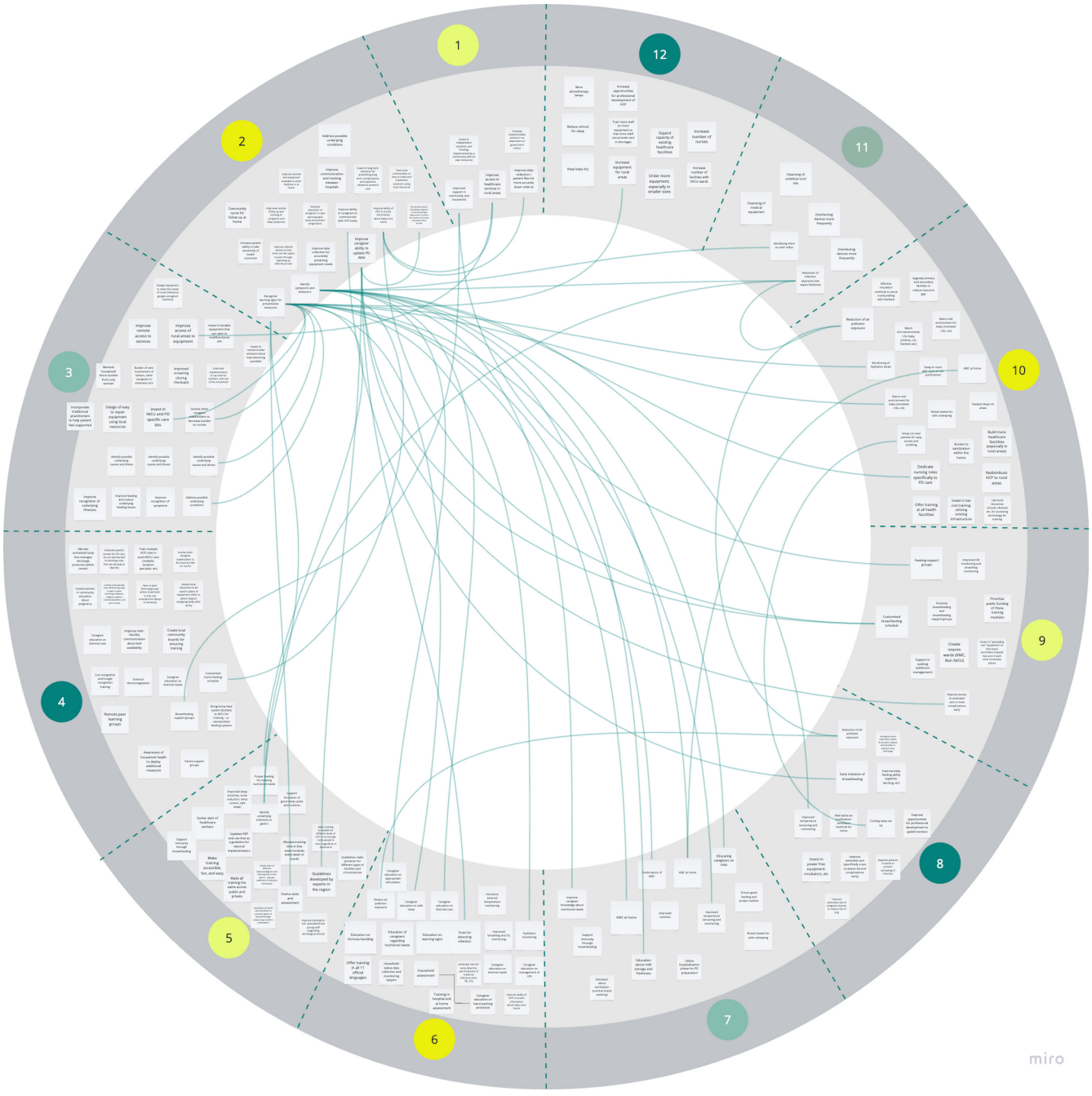


Figure 36: Leverage Wheel

The most interconnected interventions from the leverage wheel could be split up into two categories of clear intervention objectives:

Symptom Recognition

Recognize warning signs and take preventative measures
Identify symptoms and behaviors to provide better care

Remote monitoring and data access

Improve caregiver ability to update health status post discharge
Improve ability of healthcare providers to access information about baby post discharge
Allow caregivers to communicate with healthcare providers easily and remotely

Bringing it all together: Design Conclusion and Hierarchy

At this point, it was December, and the end of the first half of my capstone project. It was time to conclude my research, map building, and deep thinking. I needed to narrow down all my work to my design conclusion: what was I going to design in order to lower the number of deaths of premature babies in South Africa, after discharge from hospital?

My solution: a post discharge care kit and remote health monitoring system, consisting of data collection, preventative, connection/alert, and educational tools.
Now that this had been clarified, I could move on to the next part of my journey, which would quite literally transport me halfway across the world...

6

Field Research: A Visit to South Africa

- Field research: Tygerberg Hospital
- Ethnographic observations: Healthcare facilities in South Africa
- Findings and Design Adjustment

Field Research: Tygerberg Hospital

My capstone project received vital funding from Kwantlen Polytechnic University's Student Research Innovation Grant (KPU SRIG 2024-70), enabling me to conduct on-site ethnographic research in South Africa during my winter break. This trip aimed to deepen my understanding of how my product would function within its intended environment.

I travelled to Cape Town, where I had arranged a visit to Tygerberg Hospital, the second largest hospital in South Africa and the largest district general hospital in the Western Cape province. I met with one of the Neonatologists, who gave me a tour of the NICU and Kangaroo Mother Care wards. I was shocked at the state of the hospital. The concept of "under resourced" became all too real.

Mismatched bed frames and uncovered mattresses for parents beside their babies' incubators. Security was tight, requiring passage through two checkpoints due to the high risk of infant abduction. Each of the eight neonatal care floors was filled with premature babies.

This visit marked my first direct encounter with the sheer fragility of premature infants. As we toured the wards, my eye skimmed over the first row of incubators, my heart skipped a beat, and my breath caught in my throat. I glimpsed a baby so small he could have fit within my cupped hands. We continued the tour, but that moment stayed etched in my mind.

I also presented my concept to nurses and neonatologists on duty. The feedback was overwhelmingly positive. They affirmed that a tool for at-home preemie health monitoring would be transformative, given that over 60% of families at Tygerberg do not return for follow-up appointments. They emphasized the necessity for a low-cost, user-friendly tool, suggesting that growth tracking and bacterial infection monitoring would be valuable starting points.

Additionally, I visited a local backpack and soft product manufacturing facility, discussing supply chains and manufacturing challenges with the head designer and manager. I also consulted with the founder of a local baby carrier brand, gaining insight into local physical product production.

Figure 37: Me at Tygerberg Hospital

Ethnographic observations: Healthcare facilities in South Africa

During my time in South Africa, everything became a learning experience. Wherever I went, I looked critically at my surroundings. I was able to take pictures and make notes of any healthcare facilities I passed by.
Something that caught my eye was how almost everyone I passed by had a cellphone on them. Even in the poorer communities, these cellphones were often smartphones. This was a positive indicator that my product could have a technological component.

Figure 38: Rural Community in the Western Cape Province

Figure 39: Rural Community in the Eastern Cape Province

Figure 40: Rural Healthcare Clinic in Zambia

Figure 41: Rural Community in Zambia

Figure 42: Semi-rural Community in the Western Cape Province

Figure 43: Tygerberg Hospital, Cape Town - the Largest Hospital in the Western Cape and the Second Largest Hospital in South Africa

Figure 44: Groote Schuur Hospital, Cape Town - a Government Funded Teaching Hospital Famous for Being Where Dr Christiaan Barnard completed the world's first successful human heart transplant

Findings and Design Adjustment

My time in South Africa cemented my understanding that my design needed to be adaptable, low-cost, and aimed at helping parents track their baby's health from home.

Initially, I envisioned a dual-component product: a post-discharge care kit with basic monitoring tools that could be sent home with parents, integrated with a data-processing app for health data interpretation and follow-up prompts. It would allow healthcare facilities to stay connected with families, even after they had been discharged.

I had a choice to make: because of my capstone project timeline and scope, I needed to narrow it down to starting with one product. I didn't have the time or resources to develop both an app and a physical kit.

With careful consideration and input from my professors, I decided to narrow it down to the app. I knew that without the tracking and processing component, I would not be able to achieve my goal of monitoring health and identifying warning signs. The kit, while useful, would only enable families to collect data, not interpret it in a way they could prompt them to seek follow up. It would also not connect them with healthcare facilities. It made the most sense to develop the app first, and then return to the kit as a future development.

And so, I set forth on my prototyping journey.

7

Prototyping

> Market Analysis

> Prototype 1: Low-Fidelity Models

> Prototype 2: Mid-Fidelity Models

> Prototype 3: Branding

Market Analysis

My initial step involved a comprehensive analysis of existing baby tracking applications. I systematically downloaded and documented each app, capturing screenshots of every screen. These screenshots were then arranged into user flows on a whiteboard, enabling a comparative assessment of each app's user interface and information architecture.
To distill key features, I employed dot-voting, a design thinking technique that facilitates the identification of compelling elements.

This process yielded a curated list of features, including:

- Neonatal unit sign-in functionality
- Hospital selection capabilities
- NICU password/code access
- "No code yet? Get your clinic to sign up!" prompts
- Inclusion of partner and caregiver information (e.g., age)
- Positive affirmation delivery
- Baby photo and gestational age at birth display
- Support for multiple babies (e.g., twins)
- Comment addition functionality
- Growth tracking visualization via graphs
- Terms of use agreement prior to sign-up
- Language selection options
- Support and educational material access
- Parent support group connectivity
- "How can we support you?" inquiry sections

These features served as critical benchmarks for informing the user and information flow of my own application.

Figure 45: Market research and feature Identification Through Dot Voting

Prototype 1: Early Concepts and Low-Fidelity Models

To establish a foundational framework for my low-fidelity prototypes, I referenced the Department of Health's Integrated Management of Childhood Illness (IMCI) document.

This resource, shared by a friend who is a nursing student working in maternity wards, provides South African nurses with essential guidelines for managing childhood illnesses and identifying critical warning signs. The document guides nurses through the questions they need to ask parents to assess the health of infants.

Combining the IMCI document with insights from my research and interviews with healthcare professionals, I identified the following symptoms and illnesses for screening in my app:

- **Bacterial infection**
- **Weight (in grams)**
- **Length (head circumference and foot length)**
- **Temperature**
- **Breastfeeding or drinking poorly**
- **Irritability or lethargy**
- **Vomiting**
- **Convulsions**
- **Fast breathing**
- **Difficulty breathing**
- **Blood in stool**

This proved an invaluable resource, as I required a guideline of medical parameters to understand critical warning signs. I focused on the Young Infants (Birth up to 2 months) section of the IMCI document, which guides nurses through assessing and classifying the infant, and then identifying treatment.

However, as this guide was not specifically designed for premature babies, I needed to use my previous research to identify which symptoms and illnesses were most pertinent to identifying warning signs in preemies.

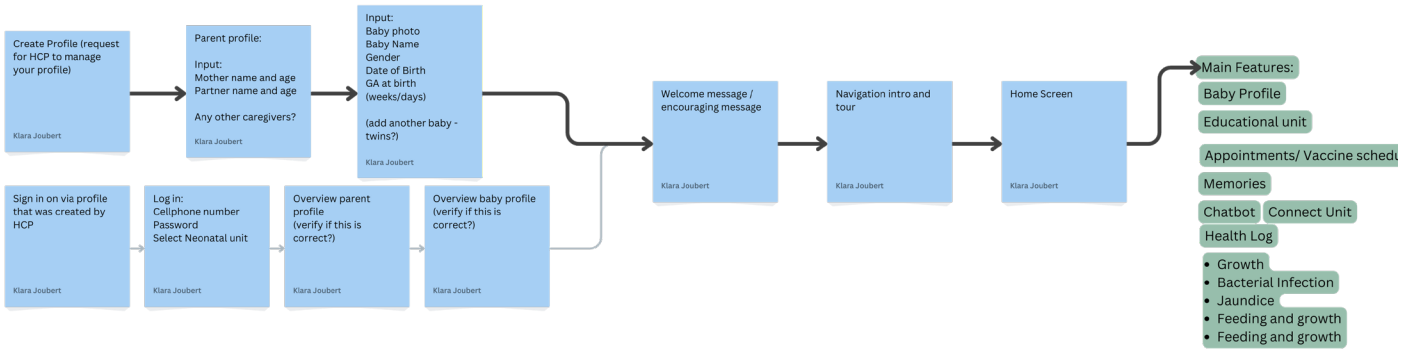
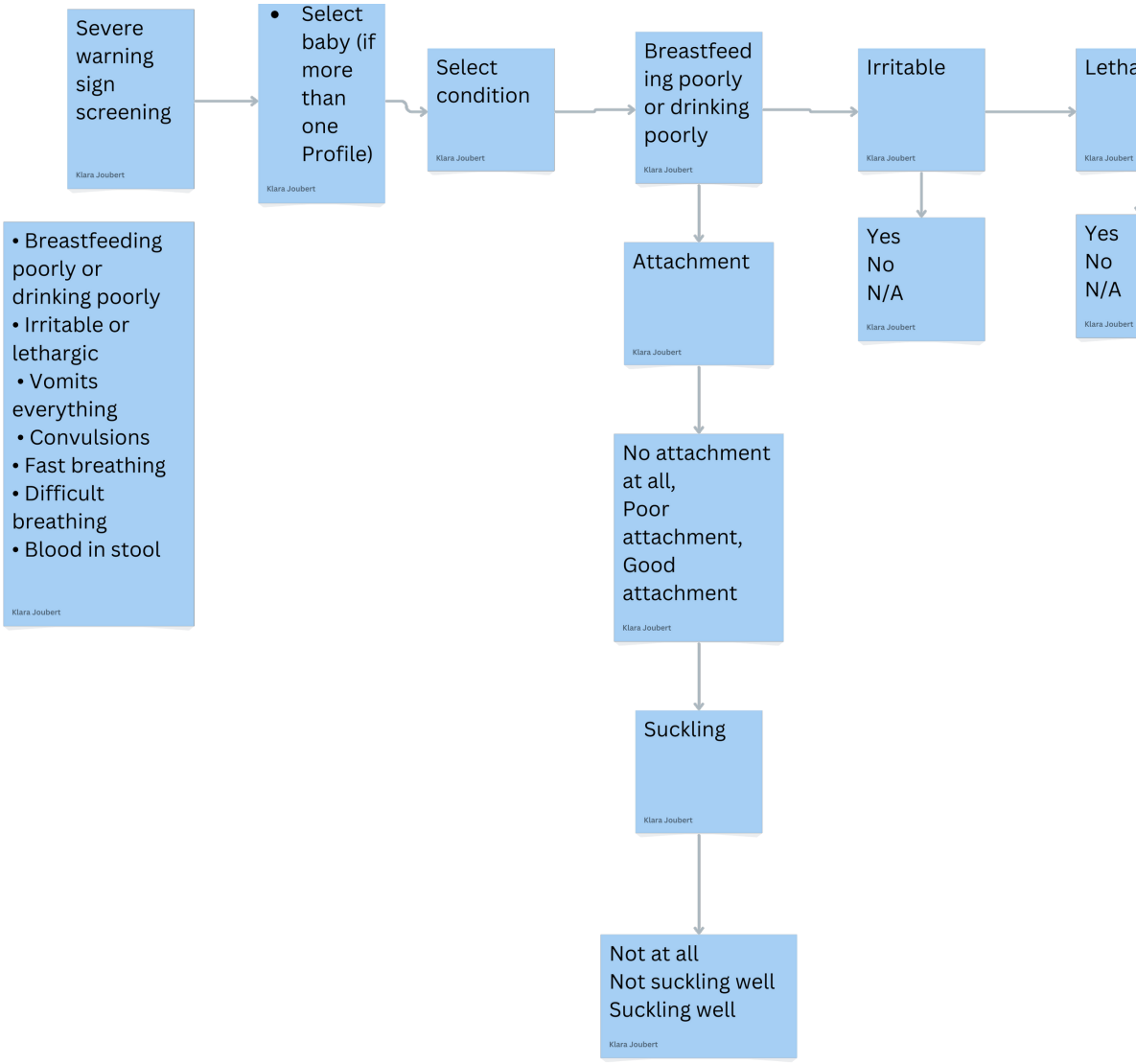


Figure 46: Low Fidelity App Flow Identifying Parent Onboarding and Warning Sign Screening



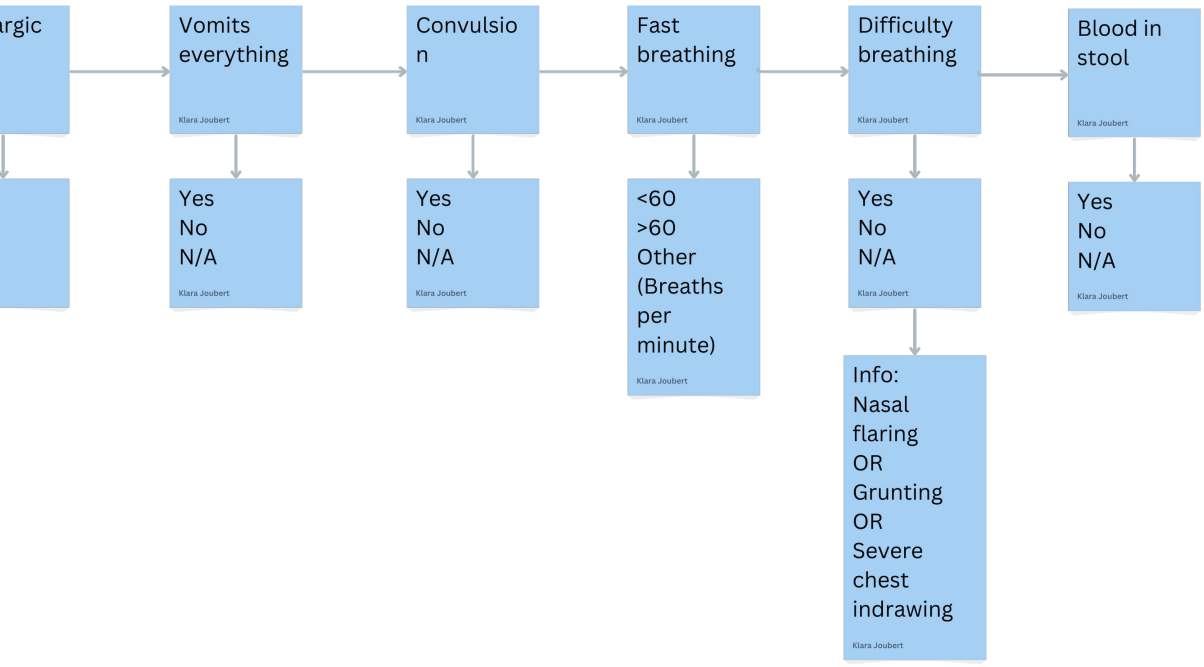


Figure 47: Low Fidelity Flow of Basic Warning Sign Screening

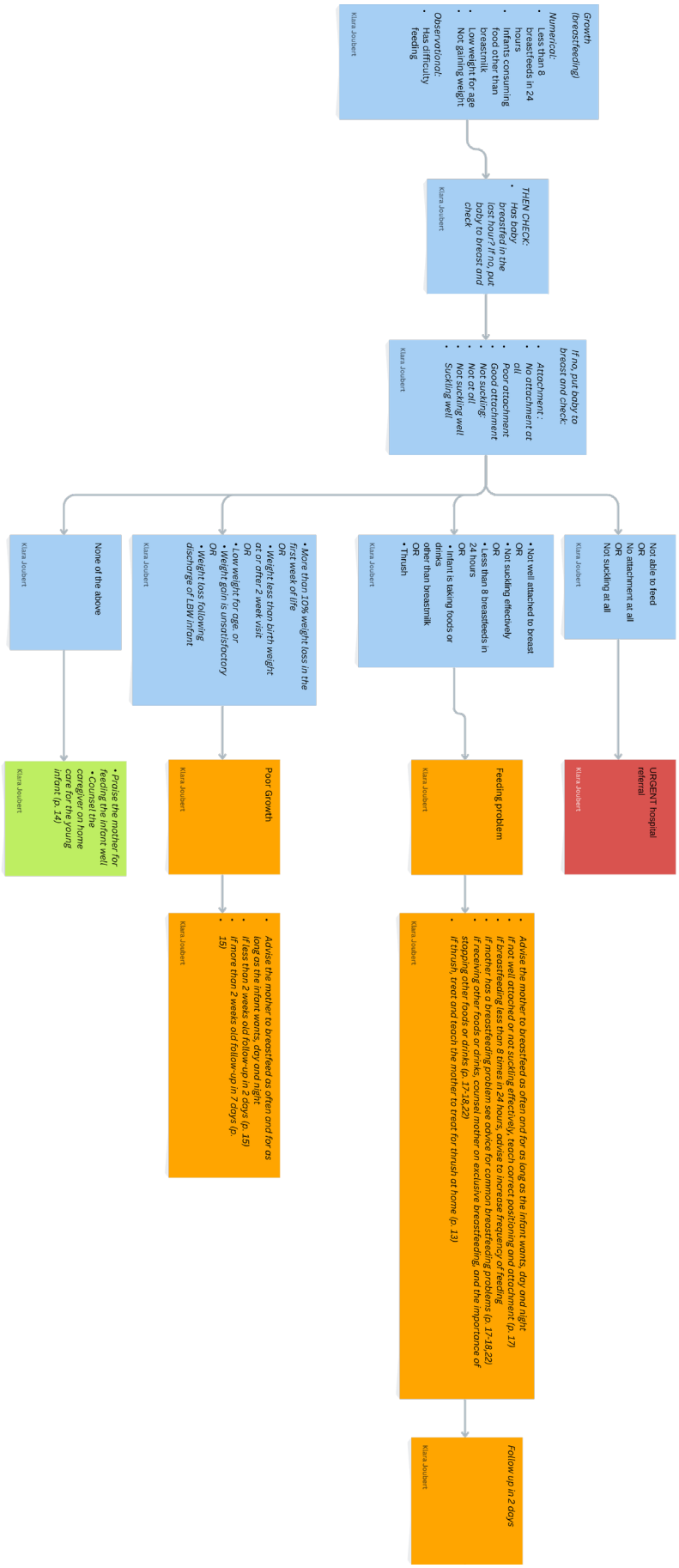


Figure 48: Low Fidelity Flow of Basic Screening for Growth When Breastfeeding

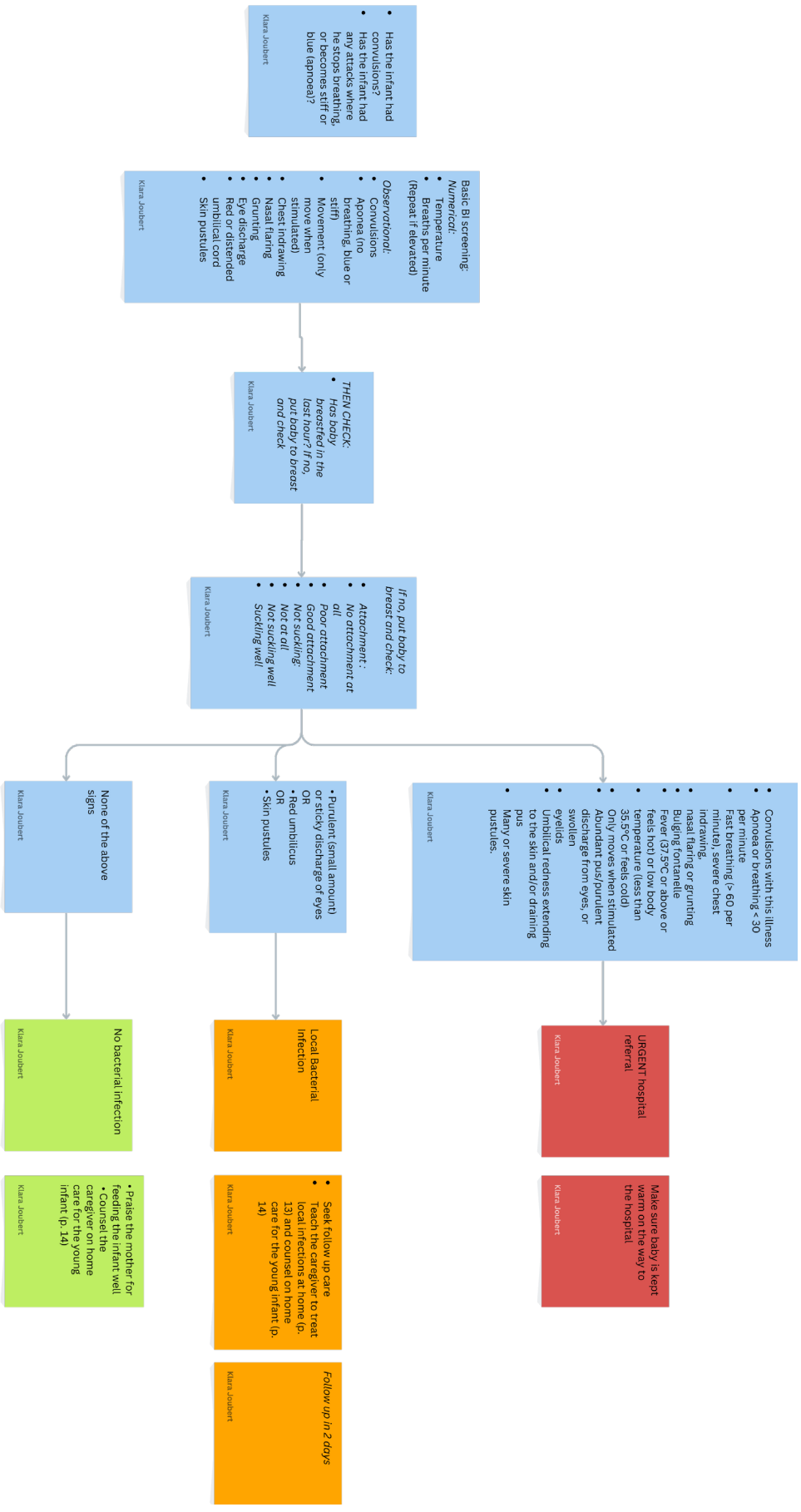


Figure 49: Low Fidelity Flow of Basic Screening for Bacterial Infection

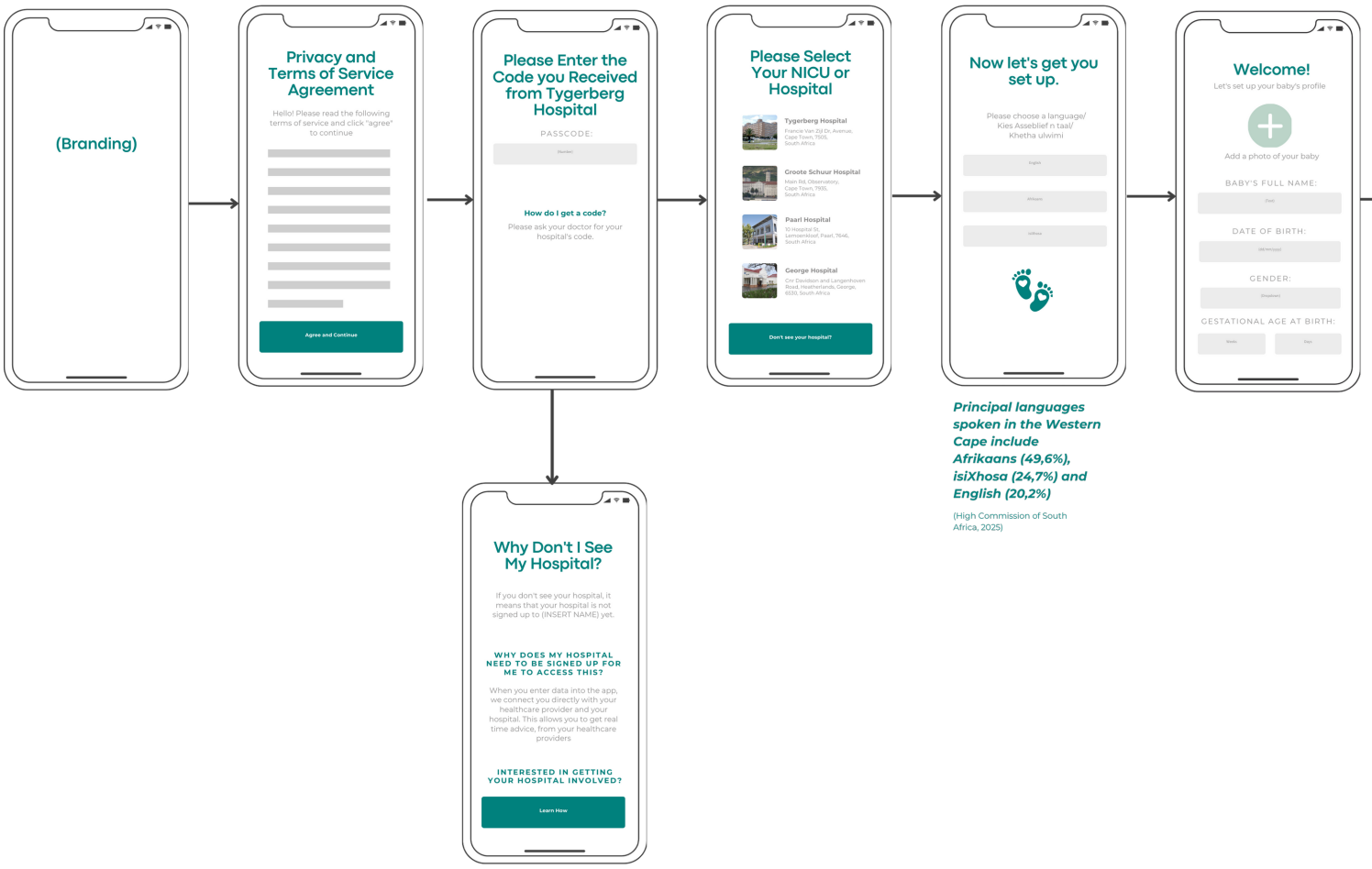
Prototype 2:
Mid-Fidelity Models

Wireframes

With the basic information architecture defined, I progressed to creating mid-fidelity wireframe prototypes. This involved developing digital mockups of the application's user interface as it would appear on a smartphone, using Canva to construct a comprehensive user flow from sign-up to symptom logging.
I incorporated features identified in my market research, particularly for the sign-up process. Parents would select their NICU, linking their account to a healthcare facility for data verification and follow-up access.

The profile creation flow included thoughtful features such as:

- Language selection for accessibility and lowering linguistic barriers
- Gestational age at birth for development and growth tracking
- Information on both parents and any other primary caregivers
- "Add a second baby" option for twins



Principal languages spoken in the Western Cape include Afrikaans (49,6%), isiXhosa (24,7%) and English (20,2%)

(High Commission of South Africa, 2025)

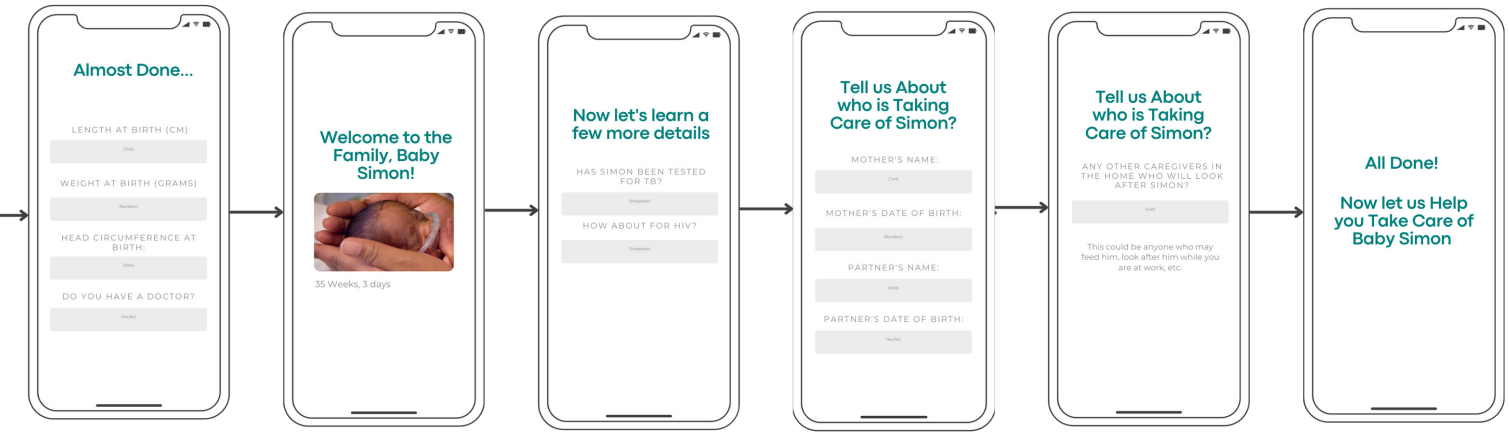


Figure 50: Flow of Parent Onboading and Baby Profile Creation

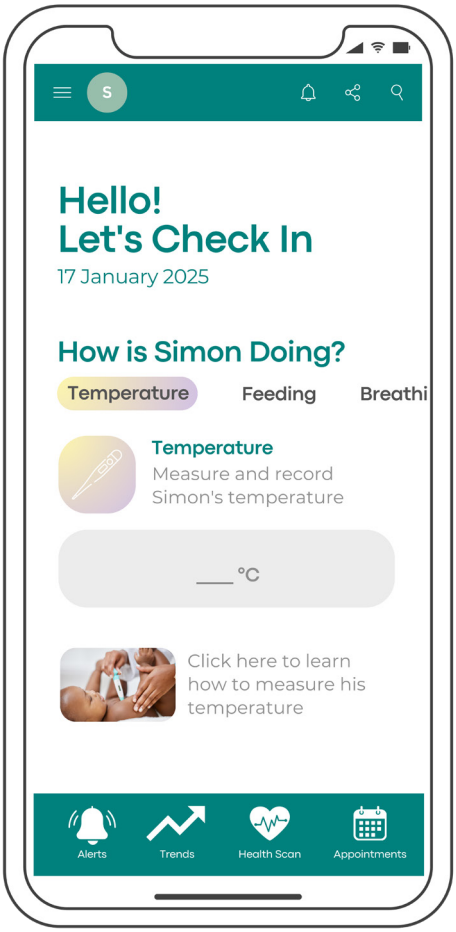
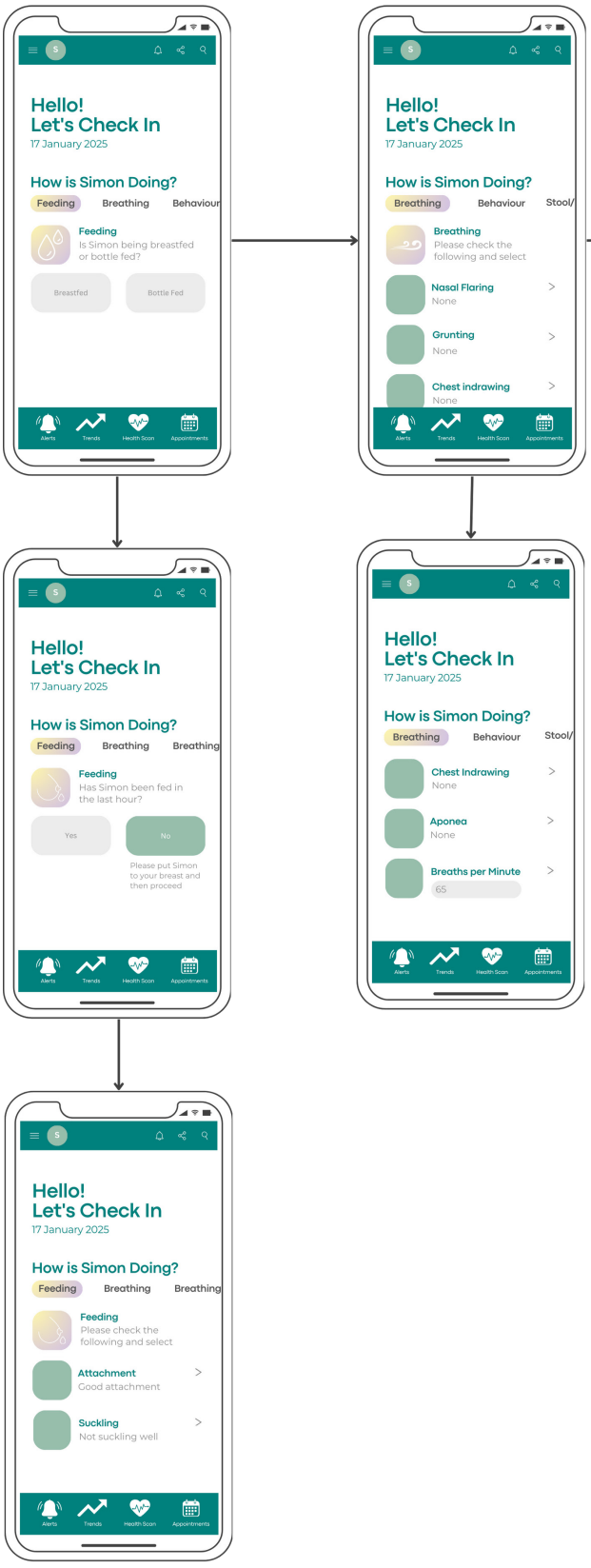


Figure 51: App Home Screen - Symptom and Warning Sign Screening



The home screen, the app's core, presented a challenge. I realized that while all the symptoms and illnesses I had identified were important for health screening, they might overwhelm parents. I needed to strike a delicate balance: gather enough information to get a holistic view of the baby's health but make it easy enough so that parents were willing to do it every day, with relative ease.

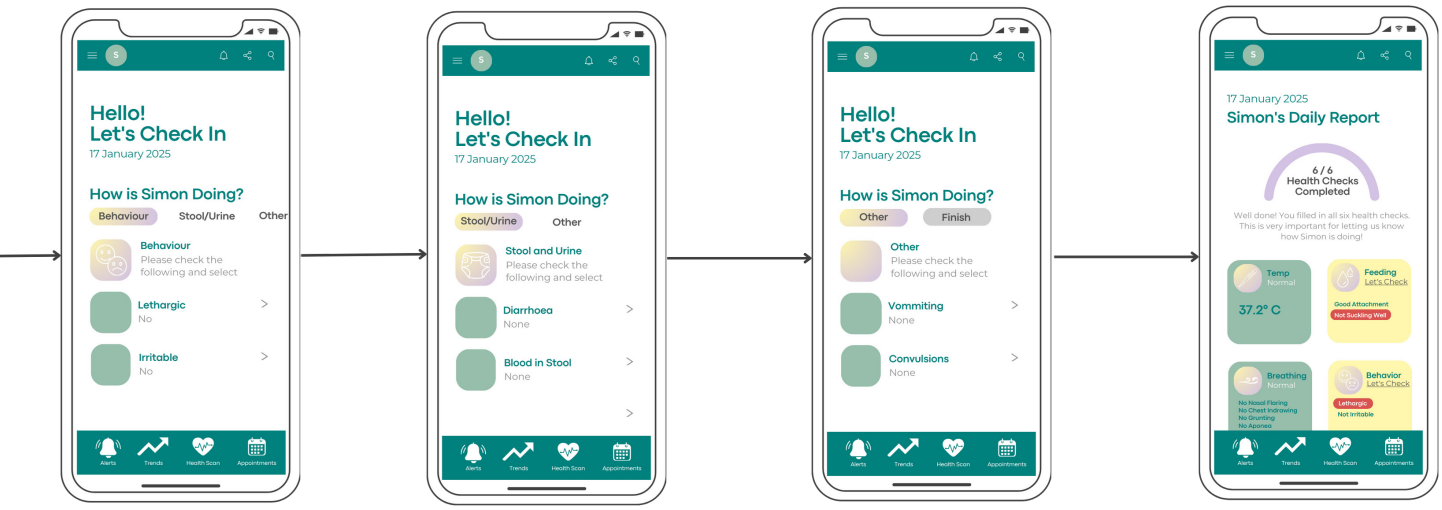


Figure 52: Flow of Health Screening

I made the health screening front and center as my homepage. This meant that whenever opening the app, parents would immediately be prompted to assess their infant's health. This increases the likelihood of them filling it out each day, while keeping the main purpose of the app central.

Now that I was working with the visual layout of the app, I was able to start grouping symptoms and illnesses, narrowing the screening down to six broad "categories of health" with sub-sections:

- Growth (weight, head circumference, length)
- Feeding (attachment, suckling)
- Breathing (nasal flaring, grunting, chest indrawing, apnea, breaths per minute)
- Behavior (lethargy, irritability)
- Stool/Urine (diarrhea, blood in stool)
- Other (vomiting, convulsions)

This round of prototyping focused on a user flow where no serious issues were present. Once these symptoms are entered, the parent is led to a daily report dashboard, where an overview of the baby's health is provided, and any concerning trends are highlighted. Parents can then click on these sections to learn more. They are prompted to enter any "follow up" data to get a holistic view of their baby's health. This helps build out a more accurate picture of what may be wrong so that the app can accurately and safely classify their symptoms into the correct level of concern. If the concern is low, parents are guided to resources of how to provide care, and what to look out for.

I included educational content, where applicable, to help parents accurately record symptoms. For example, symptoms linked to educational content such as videos demonstrating warning signs (i.e. the "thrush" symptom links to a video showing how thrush may look in a premature baby, and how to classify it).

A wrong tangent - Google AppSheets

While developing wireframes, a friend of mine introduced me to Google AppSheets, a no-code platform. This was perfect for me to understand low-cost app development without having any coding knowledge. However, it lacked the high-fidelity interfaces required for my app's features.
Ultimately, I decided not to pursue it as a prototyping tool, but I gained valuable insight into creating parameters for identifying data that lies outside a set parameter, and what information I needed to know to make my app work from a development perspective.

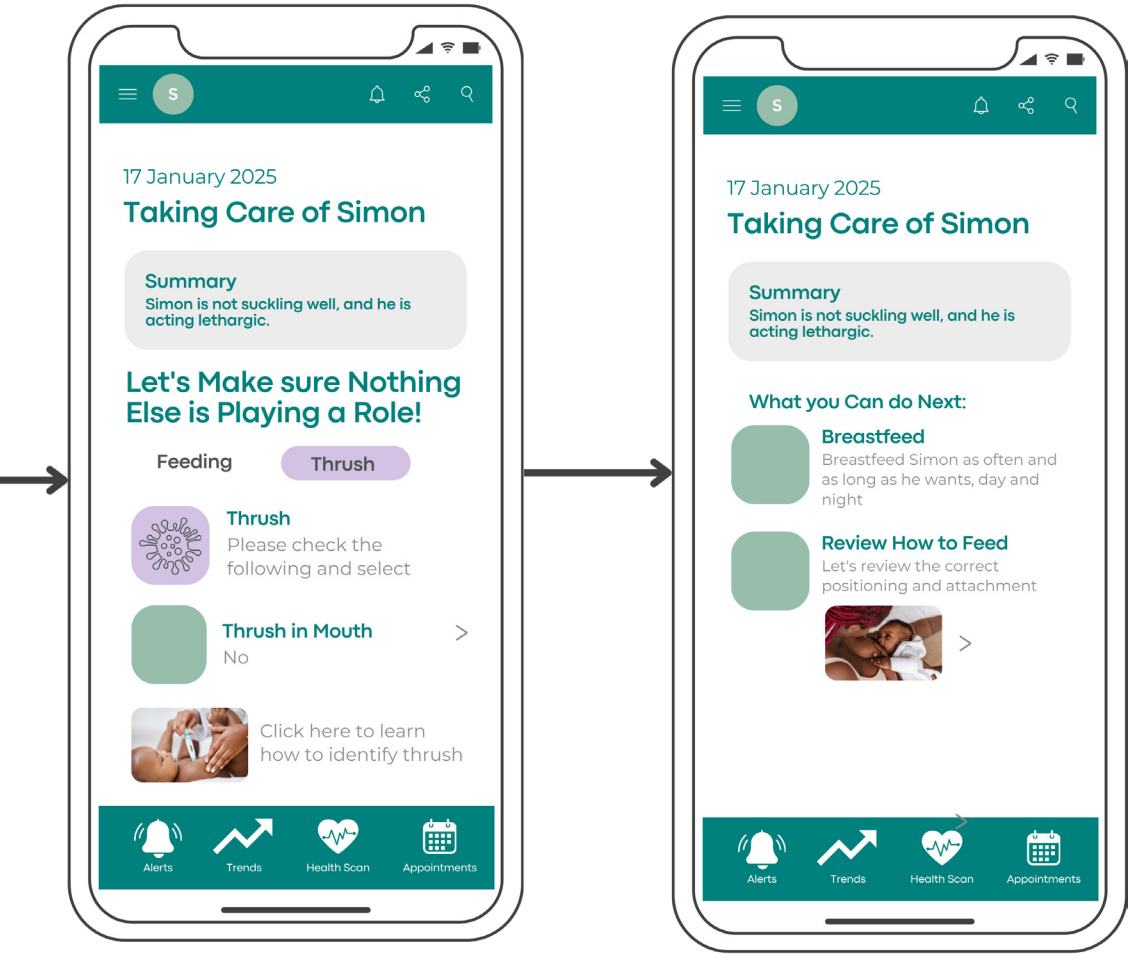


Figure 53: Flow of Health Monitoring and Warning Sign Detection

Prototype 3: Branding

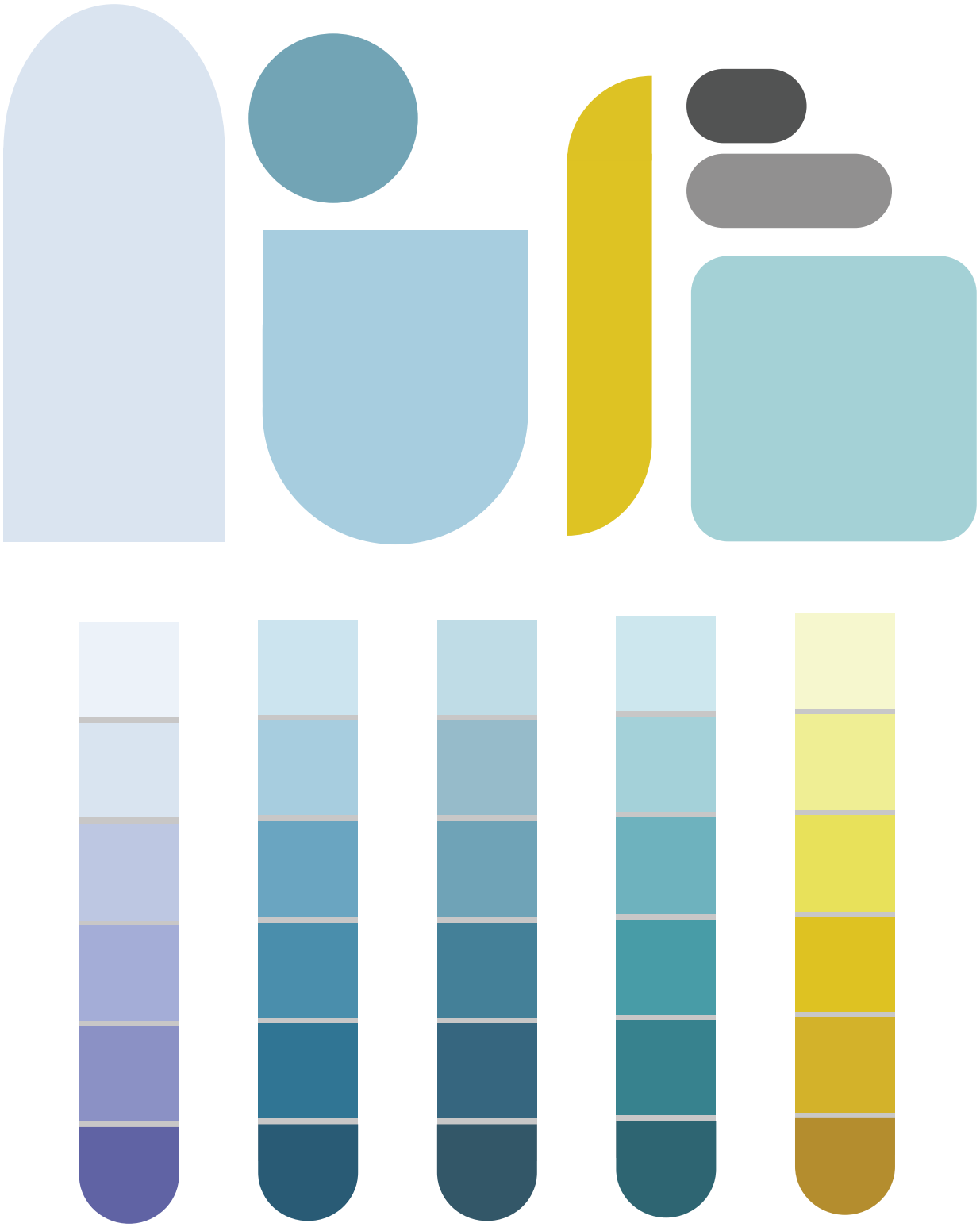


Figure 54: Colour Scheme

The development of mid-fidelity prototypes necessitated a serious branding effort. The auto-generated fonts and initial color scheme were no longer cutting it, and I really needed a name for this app.

Acknowledging my limited User Experience and User Interface training, I undertook an intensive self-directed study of app design principles (thank you, YouTube). Fortunately, the design community provides a wealth of accessible resources.

I utilized Palettemaker to generate a color palette that evoked a sense of softness and calmness, appropriate for a baby tracking application. The colors were then processed through Tailwind Colors' gradient tool and RealTime Colors for user interface visualization. Once satisfied with the color, typography, and aesthetic direction, I focused on my biggest problem: a name.

You want something short, catchy, and meaningful that summarizes your entire product in one word? Chances are it's already taken. But, with some head scratching (or banging), I eventually got there. NeoNu.

The "Neo" prefix represents neonatology, the medical specialty focused on premature infants. The "Nu" suffix derives from "NoeNoe" (pronounced "Nu-Nu"), an endearing term used in South Africa to refer to a little one. Often, if you see a baby in South Africa, you'd say "Awww, NoeNoe." This familiar phrase, representative of South African babies, served as the inspiration for NeoNu.

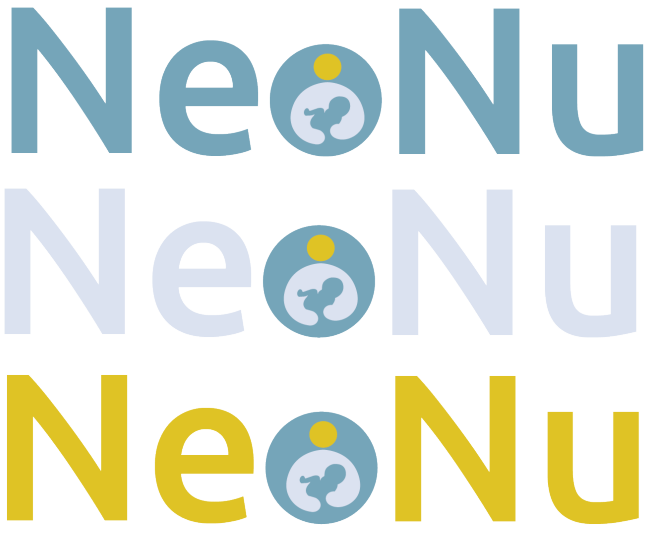


Figure 55: Combination Wordmark Logo

For the logo, I aimed for simplicity while encapsulating the application's purpose. I started by sketching out some ideas of logos and settled on the concept of a parent embracing their premature baby in their arms.
I then developed this idea in Illustrator, paying attention to design guidelines such as the golden spiral to ensure my logo read smoothly.

Figure 56: Logo Design Process

Figure 57: Pictoral Logos

8

Testing: Real World Validation

- Overview of Testing Methodology
- Parent Survey Results
- Healthcare Provider Survey Results
- Key Learnings and Design Refinements

Overview of Testing Methodology

**In product design,
user validation is crucial.**

My concept was tested through two surveys targeting distinct user groups: professionals and caregivers. Professionals included healthcare providers such as community nurses, neonatologists, midwives, pediatricians, and NICU staff. Caregivers comprised parents and other regular caretakers of premature babies. Surveys were distributed via relevant Facebook groups, including NICU and premature baby support groups, with necessary permissions obtained for private groups. Both surveys were live for just over a week, giving participants enough time to respond.

Caregiver Survey Results

The caregiver survey received 10 responses, with 90% from parents of premature babies and 10% from NICU nurses.
Key findings include:

- 66.7% of respondents found the app design clear and easy to understand with some training, while 33.3% required slightly more training.
- 100% of respondents expressed a desire for access to such an app.
- 40% felt confident in answering all screening questions, while 40% could answer some.
- Concerns were raised about access to baby scales for monitoring weight
- 100% of respondents had access to the necessary technology to download an app like NeoNu
- 90% believed the app could be implemented in healthcare facilities.

When asked about any additional feature that parents could find useful to access through the app, the following desired additional features were highlighted:

- Health summary over time (70%).
- Educational resources (70%).
- Appointment and vaccine schedule (70%).
- Appointment booking (60%).
- Healthcare provider messaging (60%).
- Developmental milestones, activity suggestions for development, and 24hr healthcare access were also requested.

Respondents highlighted the app's potential to reduce anxiety and the lack of post-discharge information, expressing their interest in using an app like NeoNu. Concerns included data privacy, liability, and the app's impact on parental instincts, and that it should not disempower parents. Hospital-based rollout with pre-discharge training was suggested to train parents on how to effectively use the app. One participant mentioned that an app for tracking your journey through the NICU was being rolled out at a hospital near them – this is promising as it shows that concepts like this are feasible for implementation.

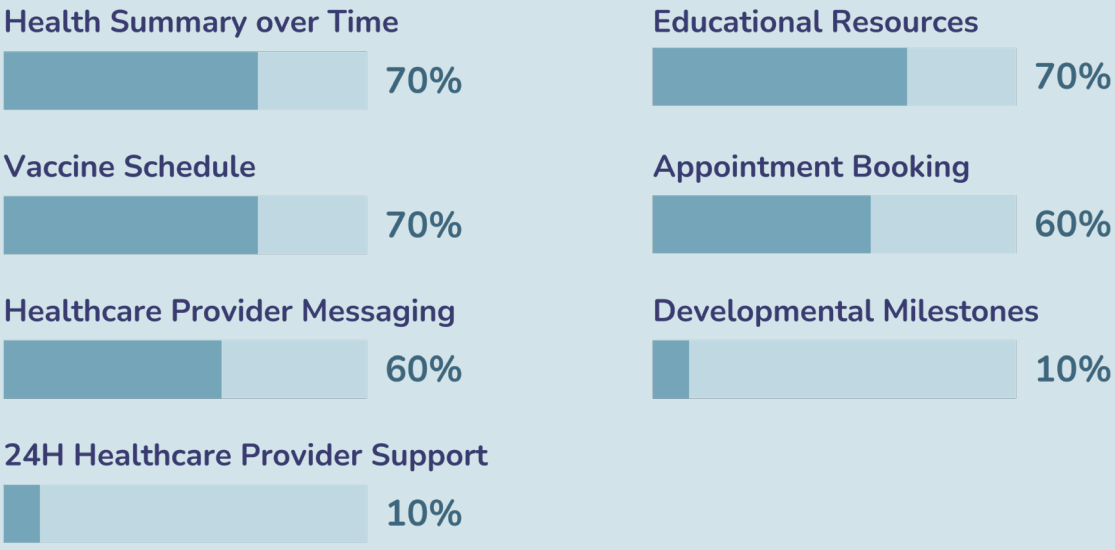
100% of Participants Want to Use This App

90% of Participants Could Envision this App Being Used in South Africa

100% of Participants Could Answer the Questions

100% of Participants Have Access to the Technology to Download and Use the App

Desired Additional Features



Healthcare Provider Survey Results

The healthcare provider survey received 5 responses. Key findings include:

- 80% of respondents worked directly with premature babies
- 60% believed parents could identify most of the featured warning signs with training, 40% without training
- 100% saw potential for implementation and would recommend the app.
- 80% rated the app's effectiveness in detecting warning signs as "very effective," 20% as "extremely effective."
- Technology access of families was deemed sufficient by 60% of respondents, while 20% felt that some families have appropriate access to implement the app. A further 20% indicated that half of the families may have the necessary access.

Desired additional features included:

- Healthcare provider messaging (80%).
- Appointment booking (80%).
- Appointment and vaccine schedule (80%).
- Educational resources (40%).
- Health summary over time (20%)

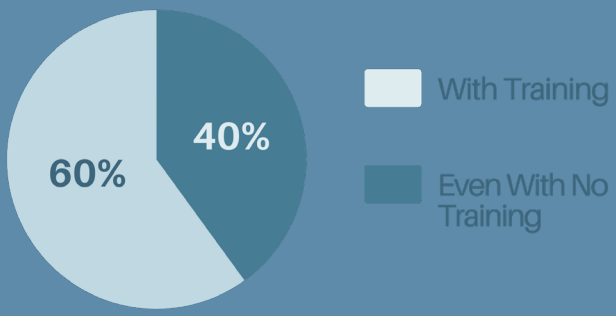
Participants suggested using simpler terms, as some parents may struggle to understand and identify the medical terms such as lethargy, convulsions, or grunting. Additionally, participants suggested also screening for the colour of the babies' skin, toes, nail beds, and lips to help identify jaundice, skin irritations, and hypothermia. Suggestions also included NGO integration for data interpretation and app rollout in low resourced settings.

Participants inquired about data evaluation and whether parents would receive detailed feedback via the app, or just an overview of their baby's health. Concerns were raised about implementation in low-resource settings, particularly with regards to access to technology.

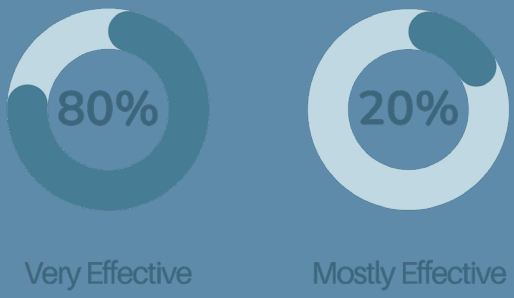
100% of Healthcare Workers Would Recommend This App to Families

100% of Healthcare Workers Could Envision this App Being Used in South Africa

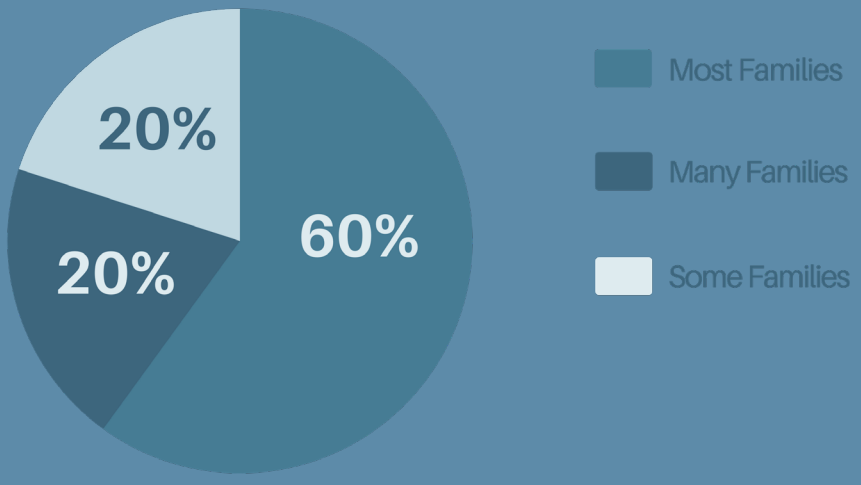
Healthcare Providers Felt Parents Could Collect the Data for the App Easily



Healthcare Providers Felt The App Would be Very Effective in Detecting Warning Signs



Healthcare Workers Believe Families Have Access to the Necessary Technology to Use the App



Key Learnings and Design Refinements

Based on survey results, the following design refinements were identified:

- Integration of requested additional features, including health summaries, educational resources, appointment scheduling, and messaging.
- Simplification of medical terminology.
- Inclusion of skin, nailbed, toe, and lip color screening for jaundice and hypothermia.
- Consideration of data security and privacy.
- Exploration of strategies to support isolated parents.
- Development of comprehensive educational tools.
- Implementation of pre-discharge training.
- Design of an effective alert system.

Both caregiver and healthcare provider groups validated the design's merit and feasibility. Key concerns centered on data processing, privacy, and implementation costs. These findings provide a solid foundation for refining the app's functionality and accessibility.

Figure 58:
Sleeping Preemie

9

The Final Design

Figure 59: Logos


Hello!
Let's Check In
17 January 2025
How is Simon Doing?
Behaviour
Stool/Urine
Other
Behaviour
Please check the following and select
Lethargic
No
Irritable
No
Summary
Simon is not suckling well, and he is acting lethargic.
Click here to learn to help him!
Simon's Daily Report
17 January 2025
6/6 Health Checks Completed
Well done! You filled in all six health checks. This is very important for letting us know how Simon is doing!
Temp
Normal
37.2° C
Breathing
Normal
Feeding
Let's Check
Good Attachment
Not Suckling Well
Behavior
Let's Check
Lethargic
Not Irritable
Taking Care of Simon
17 January 2025
Summary
Simon is not suckling well, and he is acting lethargic.
Let's Make sure Nothing Else is Playing a Role!
Thrush
Feeding
Please check the following
Select
Chest indrawing
None
Feeding
Is Simon being breastfed or bottle fed?
Breastfed
Bottle Fed
Breathing
Behaviour
Alerts
Trends
Health Scan
Appointments

NeoNu

PRODUCT DESIGN
KLARA JOUBERT

NO BABY SHOULD DIE BECAUSE THEY WERE SENT *HOME.*

Hospitals fight to keep them alive.
But once they're sent home, parents are
left without the tools they need to monitor
their premature baby.

NeoNuhelps parents catch danger early, because being sent home shouldn't mean being on their own.

Figure 60: Presentation Poster

WILSON SCHOOL OF DESIGN

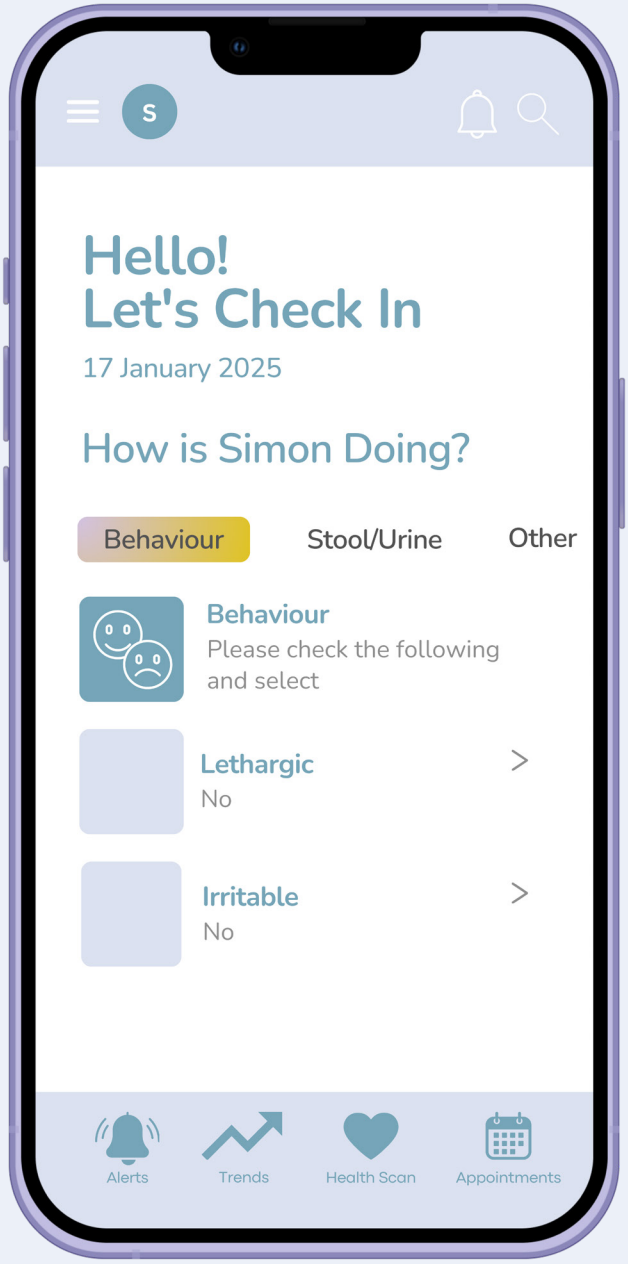


Figure 61: App Home Page for Health Monitoring

NeoNu

PRODUCT DESIGN
KLARA JOUBERT

84 000
South African Babies are Born Prematurely Each Year

1 in 10
Preterm Babies in Low Income Countries Survive

91.2%
of South African Households Used Cellular Phones in 2023

NeoNu

Get Signed Up → Track Baby's Health → Spot Risks Early → Recieve Instant Alerts → Receive Follow Up Care

Figure 62: Presentation Poster

WILSON SCHOOL OF DESIGN

Figure 63: App Health Dashboard

10

Discussion

> Systems Thinking and The Role of Design in Medical Innovation
> Scalability & Implementation in South Africa

Chapter 10

Systems Thinking and The Role of Design in Medical Innovation

Systems thinking provides a crucial framework for tackling complex, “wicked” problems.

Systems thinking provides a crucial framework for tackling complex, “wicked” problems. It allows us to understand the intricate nature of these issues, identify root causes, and therefore develop the most effective interventions and solutions. This mindset should be applied to any problem we aim to solve. At a glance, it may sound like a cumulation of marketing buzzwords, but on a deeper level it is a mindset that allows us to bring about real, measurable change.

Too often, design focuses on creating aesthetically pleasing solutions rather than addressing fundamental needs. Designers sometimes solve the problem that they want to solve, not the one that needs to be solved. It can be tempting to be swept up in the glory and shimmer of an aesthetic design that sounds impressive

While designing incubators from scrap materials or revolutionizing NICU equipment is appealing, true systemic change often lies in improving basic infrastructure: education, access to care, and resource-based health monitoring. These improvements have the most significant impact on a large scale. Systems design should be the first port of call for solving “wicked” problems, the first tool we reach for in the face of adversity.

Scalability & Implementation in South Africa

One of the most frequent questions I get asked about my project is how feasible this design really is. It is a very valid question! We could pick apart this design and find reasons why it could not work. Not every single family in South Africa will have access to a smartphone. Not every hospital will have resources for extensive training and follow-up. Not every parent will use the app consistently enough to pick up every possible health condition.

However, we cannot focus on the most extreme cases when it comes to creating progress. Instead, let's focus on what we do know. Currently, there's no tool bridging the gap between hospital discharge and home care for premature babies.

During an interview with a retired pediatric surgeon, I inquired about the peri-viability rule regarding premature infants. My research indicated that in South African hospitals, extremely premature babies undergo an initial viability assessment before receiving medical care. This is because their survival chances are significantly lower compared to less premature infants. Hospitals must prioritize their limited resources to care for those babies with a higher likelihood of survival. I posed my question, half-hoping he would tell me that this rule was obsolete. However, he confirmed its continued application. This struck me deeply; it felt incredibly harsh. How could such a practice still exist?

He then explained a crucial aspect: the economics of healthcare. Government funding is finite, necessitating a focus on providing care to the majority. This approach may not always include those in extreme circumstances. If we want to see progress, if we want to help those who fall into the "extremes" category, we must strive to shift the overall healthcare curve. By effectively serving the majority, we create the potential to reallocate resources and broaden our reach. In essence, by helping the many, we pave the way to assist the few.

NeoNu, while not a universal solution, is a vital step forward. Progress also breeds more progress. If NeoNu can reach even a few families who have smartphones, we can begin to think bigger. Seeing is believing, and with design innovation, nothing is as powerful as a working "proof of concept." It makes your vision appealing to investors, users, and other designers. It makes it possible to dream big and see a future where every premature baby has access to the care they need.

That being said, through my research I am confident that NeoNu is not such a reach. The 2023 South African General Household Survey [11] confirmed that the overwhelming majority (92.1%) of households in the country owned a cellphone in working order. Additionally, more than three-quarters (78,6%) of South African households have at least one member who has access to or uses the Internet. We also know that these trends are moving in a positive direction as more South Africans and more South African households become more connected to the internet and technology.

The conversations I had with healthcare providers corroborated these findings; they could see NeoNu being rolled out in hospitals and clinics across South Africa. Parents and caregivers were especially optimistic, with one participant even requesting the download link for NeoNu. NeoNu's implementation is viable in South Africa. Given the rapid advancement of technology and increasing accessibility, the future potential for this design solution is boundless.

11

Conclusion: The Path Forward

Grit and Growth: The Challenges

Overwhelm. Anxiety. Doubtfulness. These are some of the emotions that have been prevalent throughout this project.

Let's be honest, the design process is less of a gentle stroll and more of a full-contact sport, and this particular project decided to play rough.

In the beginning, I felt quite lost in the vastness of the problem. I struggled to narrow down my problem to something specific. I thought the answer would become clearer the more research I did. However, the more research I did, the more problems I identified. My professors urged me to narrow down my problem, and we played a delicate game of negotiation.

"Klara, what's the main problem you're trying to solve?" "I'm not entirely sure, but I can assure you, it's going to be monumentally important!" "Right... and when might this epiphany occur?" "Any minute now! Just after I finish reading this 120-page document that will, without a doubt, illuminate everything."

Cue endless reading, frantic map-making sessions, and long, contemplative walks that probably looked more like pacing. Eventually (either because I had to or because I was ready to), I narrowed it down:

"Professors, I'm delighted to announce I have an answer!" (Collective sigh of relief) "Thank goodness. What are you solving?" "I'm creating a tool to identify post-discharge warning signs in premature babies, facilitating timely follow-up." "Excellent! And what will this... tool look like?" "Uh... I'm still working on that." "Okay... but what will it do?" "Well, it'll monitor warning signs, connect remote families with healthcare, provide educational resources, and maybe even-" "Klara, you're trying to kill us, aren't you?"

I must thank my professors again for trusting me and having such patience with me. I don't think I would have shown the same spirit if I were in their shoes. Anyhow, you get the gist. The first half of this project was a glorious, directionless mess. But I clung to the process, trusting that, eventually, I reach the end. Or an end, at the very least.

It was difficult to speak confidently about my progress because I didn't feel confident. However, nothing worth having comes easily. Figuring out the "how" was a logistical labyrinth. My time in South Africa was both inspiring and sobering. Viewing my home country through the lens of a young designer forced me to confront harsh realities. This is never easy for a dreamer to do.

I realized there were barriers and hurdles that I didn't know how to cross. I realized that I would not be able to help absolutely everyone (at least not at first). I realized that this wasn't a hypothetical situation – I had the opportunity to help real people, with real problems. The stakes were high.

Without the unwavering support of the healthcare workers I interviewed, I'd have thrown in the towel long ago. This was a challenging but rewarding journey, proving that even in the deepest problem-dives, solutions emerge - provided we have the right buoyancy device to help propel us back to the surface.

Final Reflections

This project was incredibly challenging, both personally and professionally, it forced me to sit in the discomfort of not knowing, for a very long time.

I think that is why we feel overwhelmed when we want to tackle big, complex problems with design. We have to get really comfortable with not being sure. That's the crux of tackling big problems: embracing uncertainty.
And that's scary as a designer, because you don't know what your outcome will be. And if you are being paid to produce something, or your livelihood depends on it, it might just be too scary to take that leap of faith and face the fact that you may not produce a product that solves absolutely every aspect of your problem. However, that doesn't mean you're doing it wrong. In fact, you're probably doing it just right.

Future Developments

NeoNu is the product of in-depth, extensive research and design.

It not only answers the primary question of how to lower neonatal mortality rates of premature babies in South Africa, but it does so with confidence and poise. As I finish my undergraduate in Product Design, I look excitedly to the future to see what it holds. I am excited to step away from this project and gain some space. With space comes perspective, and with perspective comes new ideas. With those new ideas, I'm excited to investigate how NeoNu can find its way into healthcare facilities and homes in South Africa.

Glossary

Subject Matter

Gestational Age

The length of a pregnancy counted from the first day of the mother's last menstrual period, usually expressed in weeks and days

Home Care

Medical or supportive care provided in a patient's home

Loadshedding

A planned or unplanned temporary power outage, often due to insufficient electricity supply

Midwife

A healthcare professional who provides care to women during pregnancy, childbirth, and the postpartum period

Morbidity

The condition of being diseased or the rate of disease in a population

Mortality

The state of being subject to death; the death rate

Mortality Rates

The number of deaths in a given area or period, or from a particular cause

Neonatal Mortality

The death of a newborn baby within the first 28 days of life

Neonatologist

A pediatrician specializing in the care of newborn infants, especially those who are ill or premature

Neonatology

The branch of medicine concerned with the care, development, and diseases of newborn infants

NICU

(Neonatal Intensive Care Unit)An intensive care unit specializing in the care of ill or premature newborn infants

Pediatrician

A medical practitioner specializing in children and their diseases

Post-discharge

The period following a patient's release from a hospital or other healthcare facility

Preterm Birth

(PtB) Births occurring earlier than 37 weeks of an expected 40-week full-term pregnancy

Preterm Birth Rates

The number of preterm births per 1000 live births in a population

Glossary

Design Matter

Balancing cause-effect loops:

Feedback loops that counteract change, maintaining stability in a system

Capstone Project

A culminating project undertaken by students, typically in the final year of study, to demonstrate their acquired skills and knowledge

Cause-effect loops

Diagrams illustrating how variables in a system influence each other, creating feedback loops

Design Thinking

A human-centered, iterative problem-solving process that emphasizes empathy, ideation, prototyping, and testing

Ethnographic

Relating to the study of people and cultures in their natural setting

Fishbone Diagrams

A visual tool used for root cause analysis, displaying the potential causes of a problem

High-Fidelity Models

Detailed, realistic prototypes that closely resemble the final product

Human-centered Design

A design philosophy that prioritizes the needs, wants, and limitations of end-users throughout the design process

Iceberg Diagram

A systems thinking tool that helps visualize the underlying structures and mental models contributing to events

Interventions

Actions taken to improve or modify a situation or system

Leverage Points

Strategic intervention areas within a system where small changes can yield significant, disproportionate shifts in the system's behavior or outcomes

Leverage Wheel

A tool used to identify and prioritize leverage points for intervention within a system

Literature Review

A comprehensive survey of scholarly sources to investigate current knowledge on a topic

Low-Fidelity Models

Simple, rough prototypes used to explore and communicate initial design concepts

Mid-Fidelity Models

Prototypes that are more refined than low-fidelity models but less detailed than high-fidelity models

Mind Maps

Diagrams used to visually organize information, showing relationships among different parts of a topic

Mixed-Methods Design

A research approach that combines qualitative and quantitative methods to provide a comprehensive understanding of a problem

Product Design

The process of creating new products that solve problems or meet specific needs

Glossary

Design Matter

Prototype

An early sample, model, or release of a product built to test a concept or process

Reinforcing cause-effect loops

Feedback loops that amplify change, leading to exponential growth or decline in a system

Social Innovation

The process of developing and implementing effective solutions to complex social problems

Socio-economic

Relating to the interaction of social and economic factors

Spyder Diagram

A visual tool used to compare multiple characteristics of different items or solutions

Stakeholder

A person or organization with an interest or concern in something

Systems Design

A design framework for addressing complex challenges through understanding relationships, processes, and feedback loops to create solutions that are sustainable, equitable, and responsive to the needs of diverse stakeholders

Wicked Problems

Complex, ill-defined problems that are difficult or impossible to solve due to incomplete or contradictory requirements

Wireframes

Basic visual guides used in interface design to represent the skeletal framework of a website or application

References

[1]Elliot, N., Fox, G., Smith, R., & Zourrig, H. (2018). RSMT course notes.

[2] United Nations. (2023, May 10). “silent emergency”: Premature births claim a million lives yearly | africa renewal. United Nations.

[3] South African Government. (2023, November 21). Health commemorates World Prematurity Awareness Month, 22 Nov. Health Commemorates World Prematurity Awareness Month, 22 Nov. https://www.gov.za/news/media-advisories/government-activities/health-commemorates-world-prematurity-awareness-month

[4] Born too soon: decade of action on preterm birth. Geneva: World Health Organization; 2023. Licence: CC BY-NC-SA 3.0 IGO. (https://creativecommons.org/licenses/ by-nc-sa/3.0/igo/)

[5] Ramokolo , V., Malaba , T., Rhoda , N., Kauchali , S., & Goga, A. (2019). A landscape analysis of preterm birth in South Africa: systemic gaps and solutions. South African Health Review, 2019(01), 133–144.

[6] Brink, L. T., Gebhardt, G. S., Mason, D., Groenewald, C. A., & Odendaal, H. J. (2019). The association between preterm labour, perinatal mortality and Infant Death (during the first year) in Bishop Lavis, Cape Town, South Africa. South African Medical Journal, 109(2), 102–106. https://doi.org/10.7196/samj.2019.v109i2.13438

[7]Nsubuga, R., Rujumba, J., Nyende, S., Kisaka, S., Idro, R., & Nankunda, J. (2024). Predictors of mortality among low birth weight neonates after hospital discharge in a low-resource setting: A case study in Uganda. PLOS ONE, 19(6). https://doi.org/10.1371/journal.pone.0303454

[8]De Jesus, L. C., Pappas, A., Shankaran, S., Kendrick, D., Das, A., Higgins, R. D., Bell, E. F., Stoll, B. J., Laptook, A. R., Walsh, M. C., & Eunice Kennedy Shriver National Institute of Child Health and Human Development Neonatal Research Network (2012). Risk factors for post-neonatal intensive care unit discharge mortality among extremely low birth weight infants. The Journal of pediatrics, 161(1), 70–4.e42. https://doi.org/10.1016/j.jpeds.2011.12.038

[9]Michaelis, I. A., Krägeloh-Mann, I., Manyisane, N., Mazinu, M. C., & Jordaan, E. R. (2021). Prospective cohort study of mortality in very low birthweight infants in a single centre in the Eastern Cape province, South Africa. BMJ paediatrics open, 5(1), e000918. https://doi.org/10.1136/bmjpo-2020-000918

[10]Kleinhout, M. Y., Stevens, M. M., Osman, K. A., Adu-Bonsaffoh, K., Groenendaal, F., Biza Zepro, N., Rijken, M. J., & Browne, J. L. (2021). Evidence-based interventions to reduce mortality among preterm and low-birthweight neonates in low-income and middle-income countries: a systematic review and meta-analysis. BMJ global health, 6(2), e003618. https://doi.org/10.1136/bmjgh-2020-003618

[11]Statistics South Africa. (2023). South African General Household Survey 2023. Isibaloweb.statssa.gov.za. https://isibaloweb.statssa.gov.za/pages/surveys/pss/ghs/2023/ghs2023.php

Figure References

Nairobi, Kenya. Blancquaert, L. (2023) Born too soon: decade of action on preterm birth. Geneva: World Health Organization; 2023. Licence: CC BY-NC-SA 3.0 IGO. (https://creativecommons.org/licenses/ by-nc-sa/3.0/igo/)

Figure 1: Prince Albert. (n.d.). Timbuktu Travel. Retrieved from https://www.timbuktutravel.com/region/prince-albert-trip.

Figure 2: Author's Image. (2008). My Mom (Ellen) and Dad (Anton).

Figure 3: Author's Image. (2010). Mom at the Town's Recycling Project.

Figure 4: Author's Image. (2011). Albert College.

Figure 5: Author's Image. (2005). Me and my Brother, Siemon.

Figure 6: Author's Image. (2021). My First Day at KPU in Canada.

Figure 7: Preemie in Incubator. (2019). Life Healthcare. Retrieved from https://www.lifehealthcare.co.za/news-and-info-hub/latest-news/understanding-your-premature-baby/.

Figure 8: Author's Image. (2023). Relations Map From a Previous System's Design Project (Redesigning the Healthcare System of Canada).

Figure 9: UN SDGs. Snow of Tomorrow: The United Nations Sustainable Development Goals. PowderGuide. (2019, November 11). Retrieved from https://powderguide.com/en/magazine/schnee-von-morgen/snow-of-tomorrow-the-united-nations-sustainable-development-goals.

Figure 10: Florio, J., & Florio, J. (2019). Micro Preemie with Hand for Scale. Women's Health. Retrieved from https://www.womenshealthmag.com/health/a27101432/smallest-baby-micro-preemie-discharged/.

Figure 11: Netcare. (2017). Micro-premature baby Jazeel Hlope. Sunday Times. Retrieved from https://www.timeslive.co.za/news/south-africa/2017-11-15-sas-little-wonder-woman-weighed-395-grams-at-birth/.

Figure 12: UNICEF. (2021). Kangaroo Mother Care is helping premature babies survive and thrive in Rwanda. UNICEF. Retrieved from https://www.unicef.org/rwanda/stories/kangaroo-mother-care-helping-premature-babies-survive-and-thrive-rwanda-0.

Figure 13: NeoNurture Incubator. (2010). Design That Matters. Retrieved from https://www.designthatmatters.org/past-projects.

Figure 14: Author's Image. (2024). Mind Map: Poor Outcomes Post Discharge.

Figure 15: Author's Image. (2024). Spyder Diagram: Causes of Poor Health Outcomes of Preterm Infants After Discharge from Medical Facilities.

Figure 16: Author's Image. (2024). Spyder Diagram: Effects of Poor Health Outcomes of Preterm Infants After Discharge from Medical Facilities.

Figure 17: Author's Image. (2024). Cause Effect Loop Relating Preterm

Figure References

Figure References

Figure 40: Author's Image. (2024). Rural Healthcare Clinic in Zambia

Figure 41: Author's Image. (2024). Rural Community in Zambia

Figure 42: Author's Image. (2024). Semi-rural Community in the Western Cape Province

Figure 43: Hendricks, A. (2024). Tygerberg Hospital, Western Cape. Daily Maverick. Retrieved from https://www.dailymaverick.co.za/article/2024-10-16-budget-cuts-and-rising-patient-load-tygerberg-hospital-faces-elective-c-section-crisis/.

Figure 44: Groote Schuur Hospital. (n.d.). Wikipedia. Retrieved from https://en.wikipedia.org/wiki/Groote_Schuur_Hospital.

Figure 45: Author's Image. (2025). Market research and feature Identification Through Dot Voting

Figure 46: Author's Image. (2025). Low Fidelity App Flow Identifying Parent Onboarding and Warning Sign Screening

Figure 47: Author's Image. (2025). Low Fidelity Flow of Basic Warning Sign Screening

Figure 48: Author's Image. (2025). Low Fidelity Flow of Basic Screening for Growth When Breastfeeding

Figure 49: Author's Image. (2025). Low Fidelity Flow of Basic Screening for Bacterial Infection

Figure 50: Author's Image. (2025). Flow of Parent Onboading and Baby Profile Creation

Figure 51: Author's Image. (2025). App Home Screen - Symptom and Warning Sign Screening

Figure 52: Author's Image. (2025). Flow of Health Screening

Figure 53: Author's Image. (2025). Flow of Health Monitoring and Warning Sign Detection

Figure 54: Author's Image. (2025). Colour Scheme

Figure 55: Author's Image. (2025). Combination Wordmark Logo

Figure 56: Author's Image. (2025). Logo Design Process

Figure 57: Author's Image. (2025). Pictorial Logos

Figure 58: Kruger, H. (2019). Akhona Hili with her baby Ivakhele Hili who was born at 27 weeks. Olbios. African News Agency. Retrieved from https://olbios.org/saving-the-lives-of-the-prematurely-born/.

Figure 59: Author's Image. (2025). Logos

Figure 60: Author's Image. (2025). Presentation Poster

Figure 61: Author's Image. (2025). App Home Page for Health Monitoring

Figure 62: Author's Image. (2025). Presentation Poster

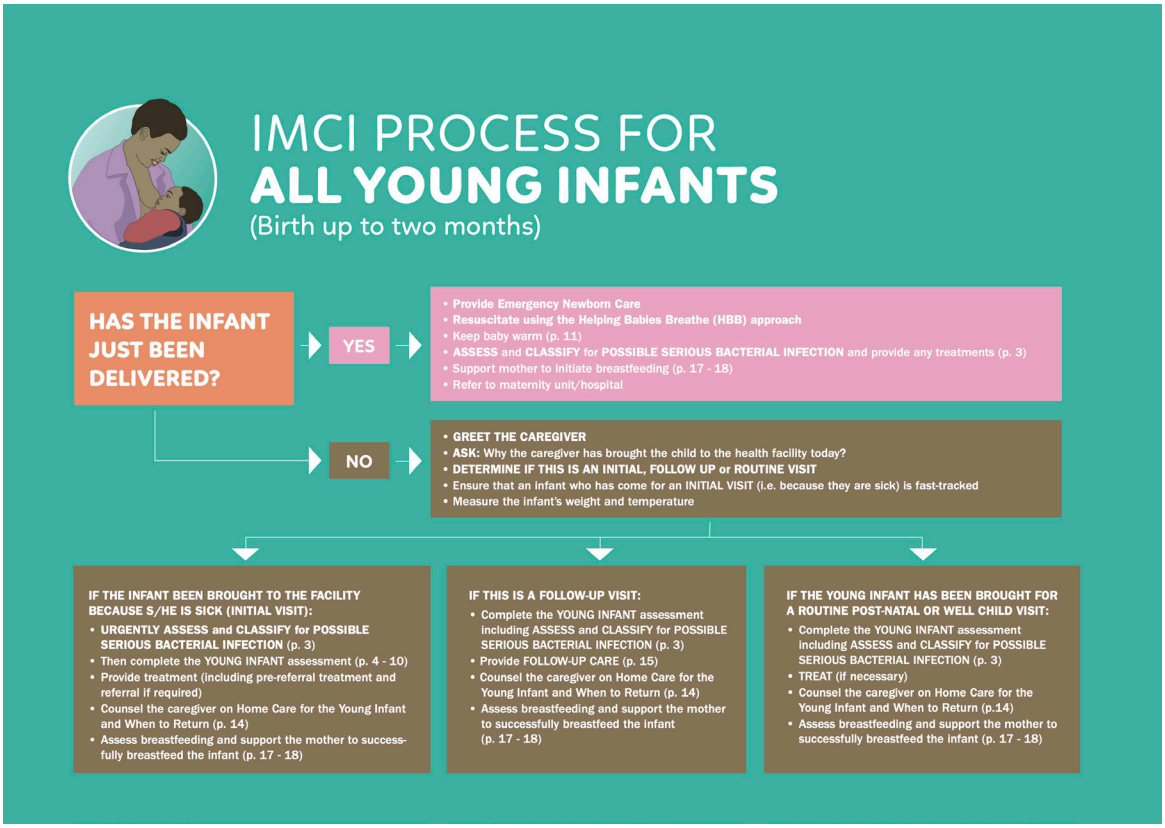
Figure References

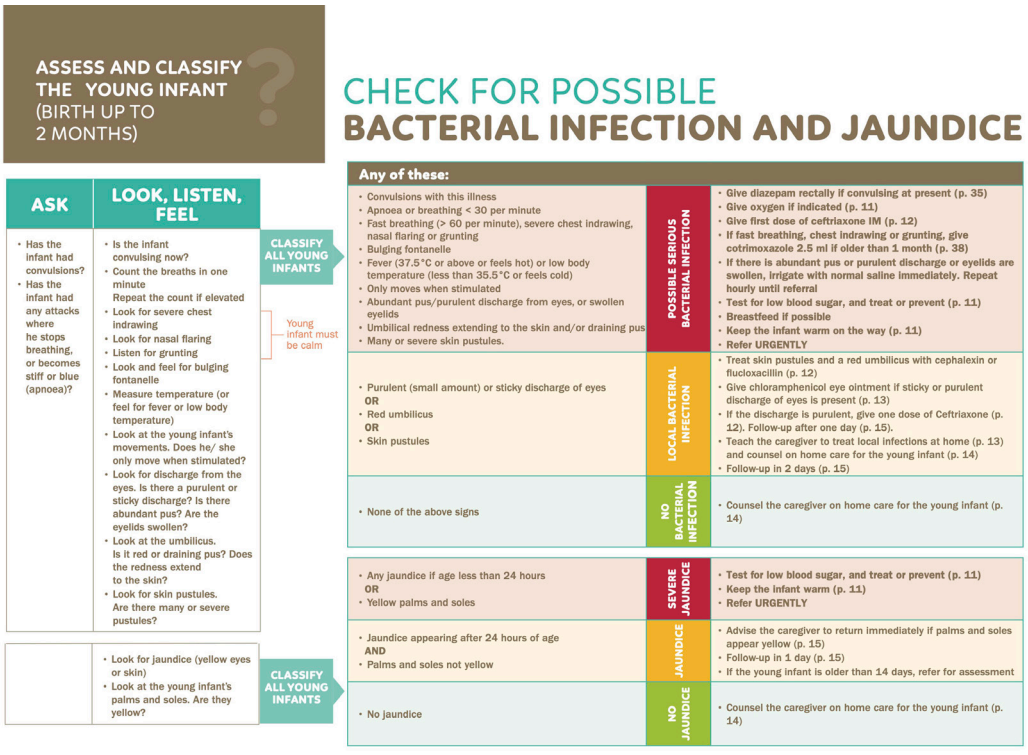
Figure 63: Author's Image. (2025). App Health Dashboard

Appendix: National Department of Health. (2022). Integrated Management of Childhood Illness 2022. South Africa.

Appendix

The Integrated Management of Childhood Illness document, instrumental for understanding which warning signs to screen for, and how.





DOES THE YOUNG INFANT HAVE DIARRHOEA?

ASK	LOOK, LISTEN, FEEL

• For how long?
• Is there blood in the stool?
	• Look at the young infant's general condition. Is the infant:
	  • Lethargic or unconscious?
	  • Restless and irritable?
	• Look for sunken eyes
	• Pinch the skin of the abdomen. Does it go back:
	  • Very slowly (> 2 seconds)?
	  • Slowly?

	A YOUNG INFANT HAS DIARRHOEA IF THE STOOLS HAVE CHANGED FROM THE USUAL PATTERN, AND ARE MANY AND WATERY (MORE WATER THAN FAECAL MATTER)

CLASSIFY DIARRHOEA

		Two of the following signs:	
FOR DEHYDRATION	SEVERE DEHYDRATION	• Lethargic or unconscious • Sunken eyes • Skin pinch goes back very slowly • Young infant less than one month of age	• **Start intravenous infusion (Plan C, p. 43)** • **Give first dose of ceftriaxone IM (p. 12)** • **Breastfeed or give frequent sips of ORS if possible** • **Keep the infant warm on the way to hospital (p. 11)** • **Refer URGENTLY**
	SOME DEHYDRATION	• Restless, irritable • Sunken eyes • Skin pinch goes back slowly	• If other severe classification, refer with breastfeeding or ORS sips on the way • Give fluid for some dehydration Plan B (p. 42) • Advise mother to continue breastfeeding • Give zinc for 14 days (p. 41) • Follow-up in 2 days (p. 15) • Counsel the caregiver on home care for the young infant (p. 14)
	NO VISIBLE DEHYDRATION	• Not enough signs to classify as some or severe dehydration	• Give fluids to treat for diarrhoea at Home (Plan A p. 42) • If exclusively breastfed, do not give other fluids except SSS • Give zinc for 14 days (p. 41) • Counsel the caregiver on home care for the young infant (p. 14) • Follow-up in 2 days (p. 15)
AND DIARRHOEA 14 DAYS OR MORE	SEVERE PERSISTENT DIARRHOEA	• Diarrhoea lasting 14 days or more	• **Start treatment for dehydration if present** • **Refer urgently** • **Keep the infant warm on the way to hospital (p. 11)**
AND IF BLOOD IN STOOL	SERIOUS ABDOMINAL PROBLEM	• Blood in the stool	• **Refer URGENTLY** • **Keep the infant warm on the way to hospital (p. 11)**

WAS THE YOUNG INFANT EXAMINED BY A HEALTH WORKERS AFTER BIRTH?

IF NO, ASSESS FOR CONGENITAL PROBLEMS

ASK	LOOK AND FEEL
• Ask the mother if she has any concerns • Ask for any identified birth defects or other problems • Was the mother's RPR tested in pregnancy? • If yes, was it positive or negative? • If positive, did she receive treatment? • If yes, how many doses? • How long before delivery did she receive the last dose?	• Measure head circumference LOOK FOR PRIORITY SIGNS • Cleft lip or palate • Imperforate anus • Nose not patent • Macrocephaly (birth head circumference more than 39 cm) • Ambiguous Genitalia • Abdominal distention • Very low birth weight (≤ 2kg) **LOOK FOR OTHER ABNORMAL SIGNS** **HEAD AND NECK** • Microcephaly (Birth head circumference less than 32 cm) • Fontanelle or sutures abnormal • Swelling of scalp, abnormal shape • Neck swelling or webbing • Face, eyes, mouth or nose abnormal • Unusual appearance **LIMBS AND TRUNK** • Abnormal position of limbs • Club foot • Abnormal fingers and toes, palms • Abnormal chest, back and abdomen • Undescended testis or hernia
SIGNS OF CONGENITAL SYPHILIS • Oedema • Pallor or jaundice • Reduced movements or irregular, jerky movements • Full fontanelle • Large lymph nodes • Large liver and/ or spleen • Respiratory distress • Small red or purple spots on the skin (petechiae) • Blisters on hands and feet	

CLASSIFY YOUNG INFANT

Any one of the PRIORITY SIGNS:		
• Cleft palate or lip • Imperforate anus • Nose not patent • Macrocephaly • Ambiguous genitalia • Abdominal distention • Very low birth weight (≤ 2kg)	MAJOR ABNORMALITY OR SERIOUS ILLNESS	• **Give diazepam rectally if convulsing at present (p. 35)** • **Give oxygen if indicated (p. 11)** • **Give first dose of ceftriaxone IM (p. 12)** • **If fast breathing, chest indrawing or grunting, give cotrimoxazole 2.5 ml if older than 1 month (p. 38)** • **If there is abundant pus or purulent discharge or eyelids are swollen, irrigate with normal saline immediately. Repeat hourly until referral.** • **Test for low blood sugar, and treat or prevent (p. 11)** • **Breastfeed if possible** • **Keep the infant warm on the way (p. 11)** • **Refer URGENTLY**
• One or more abnormal signs	BIRTH ABNORMALITY	• Keep warm, skin to skin (p. 11) • Assess breastfeeding (p. 20) • Address any feeding problems and support mother to breastfeed successfully (p. 20-21) • Refer for assessment • If not able to breastfeed, give EBM 3ml/kg per hour on the way
• Mother's RPR positive and she is - Untreated - Partially treated (fewer than three doses) - Treatment completed less than 1 month before delivery **OR** • Mother's RPR is not known, and it is not possible to get the result now	POSSIBLE CONGENITAL SYPHILIS	• Check for signs of congenital syphilis and if present refer to hospital • If no signs of congenital syphilis, give intramuscular penicillin (p. 12) • Ask about the caregiver's health, and treat as necessary (p. 10) • Ensure that the mother receives full treatment for positive RPR
• No risks nor abnormal signs	NO BIRTH ABNORMALITIES	• Counsel the caregiver on home care for the young infant (p. 14)

THEN CONSIDER
RISK FACTORS IN ALL YOUNG INFANTS

LOOK AT THE CHILD'S ROAD TO HEALTH BOOKLET AND/OR ASK:

- Has the mother or a close contact had TB or been on TB treatment in the last 6 months? If yes:
- Did the mother start TB treatment more than 2 months before delivery?
- Assess the infant for symptoms and signs of congenital TB (box below)
- How much did the infant weigh at birth?
- Was the infant admitted to hospital after birth? If so, for how many days?
- Who is the child's caregiver?
- How old is the mother/caregiver?
- Is the infant exclusively breastfed?

CHECK FOR SIGNS AND SYMPTOMS OF CONGENITAL TB

Congenital TB may be asymptomatic.

Symptoms suggestive of TB:
- Low birth weight
- Poor feeding
- Poor weight gain
- Fever
- Lethargy/ irritability
- Fast breathing/ shortness of breath
- Enlarged lymph nodes
- Enlarged liver and/ or spleen

CLASSIFY ALL YOUNG INFANTS

• Mother on TB treatment for less than 2 months before delivery AND • Infant has one or more symptoms/ signs of congenital TB	POSSIBLE CONGENITAL TB	• Refer to hospital for investigations. If diagnosed with TB the baby will need a full course of TB treatment (p. 39) • Give BCG on completion of INH or TB treatment • Ask about the caregiver's health, and treat as necessary (p. 10) • Provide follow-up (p. 51)
• Mother on TB treatment for more than 2 months before delivery AND • Infant has no symptoms/ signs of congenital TB	TB EXPOSED	• Give INH for 6 months if mother has received TB treatment for more than 2 months before delivery (p. 38) • Give BCG on completion of INH or TB treatment • Consider HIV infection in the infant (p. 7) • Ask about the caregiver's health, and treat as necessary (p. 10) • Provide follow-up (p. 51)
• Infant weighed less than 2 kg at birth OR • Admitted to hospital for more than three days after delivery OR • Known neurological or congenital problem	AT RISK INFANT	• Monitor growth and health more frequently • Assess feeding and encourage breastfeeding (p. 21 - 23) • Conduct home visits to assess feeding and growth • Encourage mother to attend follow-up appointments and refer to other services if indicated (further medical assessment, social worker, support group) • Make sure that the birth has been registered and that the child is receiving a child support grant if eligible
• Mother has died or is ill OR • Infant not breastfed OR • Teenage caregiver OR • Social deprivation	POSSIBLE SOCIAL PROBLEM	• Assess breastfeeding and support mother to breastfeed successfully (p. 21 - 23) • If not breastfeeding, counsel and explain safe replacement feeding (p. 20, 24 - 25) • Monitor growth and health more frequently • Conduct home visits to assess feeding and growth • Make sure that the birth has been registered and that the child is receiving a child support grant if eligible. • Refer to other available services if indicated (social worker, community based organisations) • No risk factors • Counsel the caregiver on home care for the young infant (p. 14)
• No risk factors	NO RISK FACTORS	• Counsel the caregiver on home care for the young infant (p. 14)

HAS THE INFANT BEEN TESTED FOR HIV INFECTION?

THEN CONSIDER HIV INFECTION IN ALL YOUNG INFANTS

IF YES, AND THE RESULT IS AVAILABLE, ASK:

- What was the result of the test?
- Was the infant breastfeeding when the test was done, or had the infant breastfed less than 6 weeks before the test was done?
- Is the infant currently taking ARV prophylaxis?

HIV testing in infants 0 - 2 months:
- All HIV-exposed infants should have been tested at birth. Ensure you obtain the result
- If the test was negative, re-test:
  - -At 10 weeks of age (all HIV-exposed)
  - -At 6 months of age (all HIV-exposed)
  - -If the infant is ill or has features of HIV infection
  - -6 weeks after stopping breastfeeding.
- Universal HIV rapid test at 18 months for all infants, regardless of HIV exposure.

Below 18 months of age, use an HIV PCR test to determine the child's HIV status. Do not use an antibody test to determine HIV status in this age group. If HIV PCR positive, do a second HIV PCR test to confirm the child's status

CLASSIFY FOR HIV STATUS

• Infant has positive HIV PCR test	HIV INFECTION	• Follow the six steps for initiation of ART (p. 52) • Give cotrimoxazole prophylaxis from 6 weeks (p. 38) • Assess feeding and counsel appropriately (p. 16 - 22) • Ask about the caregiver's health, and ensure that she is receiving the necessary care and treatment. • Provide long term follow-up (p. 57)
• Infant is receiving ARV prophylaxis	HIV-EXPOSED: ON ARV PROPHYLAXIS	• Complete appropriate ARV prophylaxis (p. 12) • Give cotrimoxazole prophylaxis from 6 weeks (p. 38) • Assess feeding and counsel appropriately (p. 16 - 22) • Repeat HIV PCR test according to testing schedule. Reclassify on the basis of the test result. • Ask about the caregiver's health, and ensure that she is receiving the necessary care and treatment. • Provide follow-up care (p. 50)
• Infant has completed ARV prophylaxis AND • Infant has negative HIV PCR test AND • Infant still breastfeeding or stopped breastfeeding < 6 weeks before the test	ONGOING HIV EXPOSURE	• Give cotrimoxazole prophylaxis from 6 weeks (p. 38) • Repeat HIV PCR test according to testing schedule. Reclassify on the basis of the test result. • Assess feeding and counsel appropriately (p. 16 - 22) • Ask about the caregiver's health, and ensure that she is receiving the necessary care and treatment. • Check the mother's VL at delivery and if suppressed repeat VL every 6 months while breastfeeding. • Provide follow-up care (p. 50)
• Infant has a negative HIV PCR test AND • Infant is not breastfeeding and was not breastfed for six weeks	HIV-NEGATIVE	• Stop cotrimoxazole prophylaxis • Counsel the caregiver on home care for the young infant (p. 14)

IF NO TEST RESULT FOR INFANT, CLASSIFY ACCORDING TO MOTHER'S STATUS

ASK
- Was the mother tested for HIV during pregnancy or since the child was born?
- If YES, was the test negative or positive?

CLASSIFY CHILD ACCORDING TO MOTHER'S HIV STATUS

• Mother is HIV-positive	HIV-EXPOSED	• Do a HIV PCR test immediately. Reclassify the child on the basis of the result • Give infant ART prophylaxis (p. 12) • Give cotrimoxazole prophylaxis from 6 weeks (p. 38) • Assess feeding and provide counselling (p. 16 - 22) • Ask about the caregiver's health, and ensure that she is receiving the necessary care and treatment. - If mother not on ART: start ART immediately - If mother on ART: check the mother's VL at delivery and if suppressed repeat VL every 6 months while breastfeeding • Provide long term follow-up (p. 50)
• No HIV test done on mother OR • HIV test result not available	HIV UNKNOWN	• If the mother is available: counsel, offer HIV testing and reclassify based on the result • If the mother is not available: do an HIV antibody (rapid) test to determine if the infant was HIV exposed If the antibody test is positive, immediately do an HIV PCR to determine if the infant is HIV–infected and manage accordingly
• Mother HIV-negative	HIV UNLIKELY	• Counsel the caregiver on home care for the young infant (p. 14) • Retest the mother at the 10 week visit, 6 month visit and every 3 months while breastfeeding

THEN CHECK FOR **FEEDING AND GROWTH**

Breastfed infants

ASK	LOOK, LISTEN, FEEL
• How is feeding going? • How many times do you breastfeed in 24 hours? • Does your baby get any other food or drink? • If yes, how often? • What do you use to feed your baby?	• Plot the weight on the RTHB to determine the weight for age • Look at the shape of the curve. Is the child growing well? • If the child is less than 10 days old: Has the child lost more than expected body weight? • Has the child regained birth weight at 10 days? • Is the child gaining sufficient weight? • Look for ulcers or white patches in the mouth (thrush)

IF THE BABY:
- Has any difficulty feeding, or
- Is breastfeeding less than 8 times in 24 hours, or
- Is taking any other foods or drinks, or
- Is low weight for age, or
- Is not gaining weight

AND
- Has no indications to refer urgently to hospital:

THEN ASSESS BREASTFEEDING:
- Has the baby breastfed in the previous hour?
- If baby has not fed in the last hour, ask mother to put baby to the breast. Observe the breastfeed for 4 minutes. (If baby was fed during the last hour, ask mother if she can wait and tell you when the infant is willing to feed again)
- Is baby able to attach?

☐ not at all **OR** ☐ poor attachment **OR** ☐ good attachment
- Is the baby suckling well (that is, slow deep sucks, sometimes pausing)?

☐ not at all **OR** ☐ not suckling well **OR** ☐ suckling well
- Clear a blocked nose if it interferes with breastfeeding

NOTE:
- Young infants may lose up to 10% of their birth weight in the first few days after birth, but should regain their birth weight by ten days of age
- Thereafter minimum weight gain should be: Preterm: 10g/kg/day or Term: 20g/kg/day

10% OF BIRTH WEIGHT = BIRTH WEIGHT divided by 10

CLASSIFY FEEDING IN ALL YOUNG INFANTS

• Not able to feed OR • No attachment at all OR • Not suckling at all	NOT ABLE TO FEED	• **Treat as possible serious bacterial infection (p. 3)** • **Give first dose of ceftriaxone IM (p. 12)** • **Test for low blood sugar, and treat or prevent (p. 11)** • **Refer URGENTLY to hospital—make sure that the baby is kept warm (p. 11)**
• Not well attached to breast OR • Not suckling effectively OR • Less than 8 breastfeeds in 24 hours OR • Infant is taking foods or drinks other than breastmilk OR • Thrush	FEEDING PROBLEM	• Advise the mother to breastfeed as often and for as long as the infant wants, day and night • If not well attached or not suckling effectively, teach correct positioning and attachment (p. 17) • If breastfeeding less than 8 times in 24 hours, advise to increase frequency of feeding • If mother has a breastfeeding problem see advice for common breastfeeding problems (p. 17-18,22) • If receiving other foods or drinks, counsel mother on exclusive breastfeeding, and the importance of stopping other foods or drinks (p. 17-18,22) • If thrush, treat and teach the mother to treat for thrush at home (p. 13) • Follow-up in 2 days (p. 15)
• More than 10% weight loss in the first week of life OR • Weight less than birth weight at or after 2 week visit OR • Low weight for age. or • Weight gain is unsatisfactory OR • Weight loss following discharge of LBW infant	POOR GROWTH	• Advise the mother to breastfeed as often and for as long as the infant wants, day and night • If less than 2 weeks old follow-up in 2 days (p. 15) • If more than 2 weeks old follow-up in 7 days (p. 15)
• Not low weight for age and no other signs of inadequate feeding • Less than 10% weight loss in the first week of life	FEEDING AND GROWING WELL	• Praise the mother for feeding the infant well • Counsel the caregiver on home care for the young infant (p. 14)

THEN CHECK FOR **FEEDING AND GROWTH**

Non-breastfed infants

ASK	LOOK, LISTEN, FEEL
• How is feeding going? • What milk are you giving? • How many times during the day and night? • How much is given at each feed? • How are you preparing the milk? • Let caregiver demonstrate or explain how a feed is prepared, and how it is given to the baby • Are you giving any breastmilk at all? • What foods and fluids in addition to replacement milk is being given? • How is the milk being given? Cup or bottle? • How are you cleaning the utensils?	• Plot the weight on the RTHB to determine the weight for age • Look at the shape of the curve. Is the child growing well? • If the child is less than 10 days old: Has the child lost more than expected body weight? • Has the child regained birth weight at 10 days? • Is the child gaining sufficient weight? • Look for ulcers or white patches in the mouth (thrush)

NOTE:
- Young infants may lose up to 10% of their birth weight in the first week after birth, then from day 7-10 regain birth weight loss
- Thereafter minimum weight gain should be: Preterm: 10g/kg/day OR Term: 20g/kg/day

10% OF BIRTH WEIGHT = BIRTH WEIGHT divided by 10

CLASSIFY FEEDING AND GROWTH IN ALL YOUNG INFANTS

• Not able to feed OR • Not sucking at all	NOT ABLE TO FEED	• **Treat as possible serious bacterial infection (p. 3)** • **Give first dose of ceftriaxone IM (p. 12)** • **Test for low blood sugar, and treat or prevent (p. 11)** • **Refer URGENTLY —make sure that the baby is kept warm**
• Milk incorrectly or unhygienically prepared OR • Giving inappropriate replacement milk or other foods/fluids OR • Giving insufficient replacement feeds OR • Using a feeding bottle OR • Thrush	FEEDING PROBLEM	• Counsel about feeding and explain the guidelines for safe replacement feeding (p. 19 - 20) • Identify concerns of caregiver and family about feeding • If caregiver is using a bottle, teach cup feeding (p. 18) • If thrush, treat and teach the caregiver to treat it at home (p. 13) • Follow-up in 2 days (p. 15)
• More than 10% weight loss in the first week of life OR • Weight less than birth weight at or after 10 days of age OR • Weight gain is unsatisfactory OR • Weight loss following discharge of LBW infant	POOR GROWTH	• Check for feeding problem (p. 21) • Counsel about feeding (p. 19 - 20) • If less than 2 weeks old follow-up in 2 days (p. 15) • If more than 2 weeks old follow-up in 7 days (p. 15)
• Not low weight for age and no other signs of inadequate feeding • Less than 10% weight loss in the first week of life	FEEDING AND GROWING WELL	• Counsel the caregiver on home care for the young infant emphasising the need for good hygiene (p. 14) • Praise the caregiver

TREAT THE YOUNG INFANT

Explain to the caregiver why the treatment is being given

Prevent low blood sugar in young infants (hypoglycaemia)

If the young infant is able to swallow:

- If breastfed: ask the mother to breastfeed the child
- If the baby is too sick to feed, give 3ml/kg per hour of expressed breastmilk on the way to hospital
- If baby has severe lethargy and cannot swallow, give the milk by nasogastric tube

If feeding is contraindicated:

- Put up intravenous (IV) line and give 10% Neonatalyte by slow IV infusion at 3ml/kg/hour (3 drops per kg/hour)
- Use a dial-a-flow to monitor the flow rate
- Example: If the baby weighs 4 kg then give 12 ml/hour

Give oxygen

- Give oxygen to all young infants with:
  - Convulsions
  - Apnoea or breathing < 30 breaths per minute
  - Fast breathing, severe chest indrawing, nasal flaring or grunting
- Use nasal prongs or a nasal cannula

Nasal prongs

- Place the prongs just below the baby's nostrils. Use 1mm prongs for small babies and 2mm prongs for term babies
- Secure the prongs with tape
- Oxygen should flow at one litre per minute

Nasal cannula

- This method delivers a higher concentration of oxygen
- Insert a FG5 or FG6 nasogastric tube 2 cm into the nostril
- Secure with tape
- Turn on oxygen to flow of half a litre per minute

Treat for low blood sugar (hypoglycaemia)

- Suspect low blood sugar in any infant or child that:
  - is convulsing, unconscious or lethargic OR
  - has a temperature below 35°C
- Confirm low blood sugar using blood glucose testing strips
- Keep the baby warm at all times

Low blood sugar (< 2.5 mmol/L) in a young infant

- Breastfeed or feed expressed breastmilk
- If breastfeeding is not possible, give 10mg/kg of replacement milk feed
- Repeat the blood glucose in 15 minutes while awaiting transport to hospital
- If the blood sugar remains low, treat for severe hypoglycaemia (see below)
- If the blood glucose is normal, give milk feeds and check the blood glucose 2-3 hourly

Low blood sugar < 1.4 mmol/L in a young infant

- Give a bolus of 10% dextrose infusion (Neonatalyte) at 2ml/kg
- Then continue with the 10% dextrose infusion at 3ml/kg/hour
- Repeat the blood glucose in 15 minutes
- If still low repeat the bolus of 2ml/kg and continue IV infusion
- Refer **URGENTLY** and continue feeds during transfer
- If neonatalyte not available add 1 part 50% dextrose water to 4 parts water to make 10% solution

Keep the infant or child warm

- Use Skin to skin to keep the baby warm, unless the mother is too ill, or if the baby is too ill and requires observation. (If this is the case, then nurse the infant in a transport incubator or wrap in blankets.)

Skin-to-Skin

- Dress the baby with a cap, booties and nappy
- Place the baby skin to skin between the mother's breasts
- Cover the baby
- Secure the baby to the mother
- Cover both mother and baby with a blanket or jacket if the room is cold

TREAT THE YOUNG INFANT

Treat for POSSIBLE SERIOUS BACTERIAL INFECTION with Intramuscular Ceftriaxone

- Give first dose of ceftriaxone IM
- The dose of ceftriaxone is 50 mg per kilogram
- Dilute a 250 mg vial with 1 ml of sterile water
- Also give one dose of ceftriaxone if the infant has LOCAL BACTERIAL INFECTION with a purulent discharge of eyes

CEFTRIAXONE INJECTION
Give a single dose in the clinic

WEIGHT	CEFTRIAXONE (250 mg in 1 ml)
>2 - 2.5 kg	0.75 ml
>2.5-3.5 kg	0.9 ml
>3.5-5.5 kg	1.25 ml

Treat Skin pustules or red umbilicus with Cephalexin or Flucloxacillin

- Give cephalexin OR flucloxacillin for 7 days
- If child has penicillin allergy, refer

CEPHALEXIN OR FLUCLOXACILLIN
Give four times a day for seven days

WEIGHT	Cephalexin syrup 125 mg in 5 ml	Flucloxacillin syrup 125 mg in 5 ml
Up to 5 kg	2.5 ml	2.5 ml
≥ 5kg	5 ml	5 ml

Give Intramuscular Penicillin for POSSIBLE CONGENITAL SYPHILIS

Give once only

- Give Benzathine Benzylpenicillin IM (injection) 50 000 units / kg into the lateral thigh
- **Dilute 1.2 million units with 4 ml of sterile water to give in the clinic**
- Refer all babies if the mother is RPR positive and the baby presents with Low birth Weight **OR** Blisters on hands and feet **OR** Pallor **OR** petechiae **OR** hepatosplenomegaly **OR** if you are unsure

WEIGHT	BENZATHINE BENZYLPENICILLIN INJECTION 300 000 units in 1 ml
2.5 - < 3.5 kg	0.5 ml
3.5 - < 5 kg	0.75ml
> 5 kg	1 ml

Give ARV Prophylaxis

Risk category	Scenario	Infant ART prophylaxis
LOW RISK (at birth)	Newborn infant of mother on ART with a VL result of <1000 copies/ ml at delivery	**Nevirapine (NVP)** for 6 weeks
HIGH RISK (at birth)	**At birth:** • Mother on ART with a VL of >1000 copies/ ml at delivery or no HIV VL available at birth/ within the last 12 weeks before birth • Mother not on ART at delivery	**Nevirapine** (NVP) for at least 12 weeks, until mother's VL is <1000 copies/ ml or until 1 week after cessation of all breastfeeding **AND** **Zidovudine** (AZT) for 6 weeks
HIGH RISK (during breastfeeding)	**During breastfeeding:** • Mother on ART with latest VL of >1000 copies/ ml • Mother not on ART	
HIGH RISK (exclusive formula feeding)	**Exclusively formula fed infant of:** • Mother not on ART at delivery • Mother on ART with VL >1000 copies/ ml at delivery or no HIV VL at birth/ with the last 12 weeks before birth	**Nevirapine (NVP)** for 6 weeks **AND** **Zidovudine (AZT)** for 6 weeks

- If at any stage the infant's HIV PCR test is positive, stop prophylaxis and initiate ART according to the six steps p 52.
- **Obtain expert advice on dosing of NVP and AZT for:**
  - Premature infants <35 weeks gestation and <2.0 kg.
  - Infants underweight for age (with WFA z-score < -3).

AGE/WEIGHT		NEVIRAPINE (NVP) SOLUTION (10mg/ml) Once daily
Birth to 6 weeks	Weight 2.0 - < 2.5 kg	1 ml (10mg) daily
	Weight 2.5 kg or more	1.5 ml (15mg) daily
6 weeks up to 6 months		2 ml (20mg) daily
6 months up to 9 months		3 ml (30mg) daily
9 months until 1 week after breastfeeding stops		4 ml (40mg) daily

AGE/WEIGHT		ZIDOVUDINE (AZT) SOLUTION (10mg/ml) Twice daily
Birth to 6 weeks	Weight 2.0 - < 2.5kg kg	1 ml (10 mg) twice daily
	Weight 2.5 kg	1.5 ml (15 mg) twice daily
> 6 weeks	Weight 3.0 - < 6 kg	6 ml (60 mg) twice daily
	Weight 6 - 8 kg	9 ml (90 mg) twice daily

TREAT THE **YOUNG INFANT**

Treat for Diarrhoea (p. 42- 43)

- If there is DIARRHOEA WITH SEVERE DEHYDRATION or DIARRHOEA WITH SOME DEHYDRATION (p.42 – 43)
- Explain how the treatment is given
- If there is SEVERE DEHYDRATION commence intravenous rehydration, give the first dose of ceftriaxone IM (p. 12) and REFER URGENTLY

Teach the Caregiver to treat Local Infections at home

- Explain how the treatment is given
- Watch her as she does the first treatment in the clinic
- She should return to the clinic if the infection worsens

Treat for Thrush with Nystatin

If there are thick plaques the caregiver should:
- Wash her hands with soap and water
- Wet a clean soft cloth with chlorhexidine 0.2% or salt water, wrap this around the little finger, then gently wipe away the plaques
- Wash hands again

For all infants with thrush
- Give nystatin 1 ml after feeds for 7 days
- If breastfed, check mother's breasts for thrush. If present treat mother's breasts with nystatin
- Advise mother to wash nipples and areolae after feeds
- If bottle fed, change to cup and make sure that caregiver knows how to clean utensils used to prepare and administer the milk (p. 23 - 25)

Treat for Skin Pustules or Umbilical Infection

The caregiver should:
- Wash hands with soap and water
- Gently wash off pus and crusts with soap and water
- Dry the area
- Apply povidone iodine cream (5%) or ointment (10%) three times daily
- Wash hands again
- Give cephalexin or flucloxacillin (p. 12) for 7 days

Treat for purulent or sticky discharge of eyes

The caregiver should:
- Wash hands with soap and water
- Gently wash off discharge and clean the eye with saline or cooled boiled water at least 4 times a day. Continue until the discharge disappears
- Apply chloramphenicol ointment 4 times a day for seven days
- Wash hands again after washing the eye

THEN CHECK THE YOUNG INFANT'S IMMUNISATION STATUS **AND IMMUNISE IF NEEDED**

IMMUNISATION SCHEDULE:				
Birth	BCG	OPV0		
6 weeks	Hexavalent1 (DaPT-IPV-HB-Hib1)	OPV1	PCV1	RV1
10 weeks	Hexavalent2 (DaPT-IPV-HB-Hib2)			

- Give all missed doses on this visit
- Preterm infants should be immunised at six and ten weeks: do not delay their immunisations. If they received OPV0 less than four weeks before they reached six weeks of age, give all the other immunisations as usual (OPV1 can be given four weeks after OPV0 or with the ten week doses)
- Include sick babies and those without a RTHB
- If the child has no RTHB, issue a new one today
- Advise the caregiver when to return for the next immunisation
- Refer to the EPI Vaccinator's Manual for more information

ASSESS THE **CAREGIVER'S HEALTH**

- Check for maternal danger signs and refer urgently if present
- Check that mother has received post-natal care according to Maternity Guidelines
- Check for anaemia and breast problems
- Ask mother about contraceptive usage, and counsel/ offer family planning
- Check HIV status and assess for ART if eligible
- If already on ART, ask about the mother's last VL
- Screen for TB and manage appropriately
- Check RPR results and complete treatment if positive
- Ask about any other problems

MATERNAL DANGER SIGNS
- Excessive vaginal bleeding
- Foul smelling vaginal discharge
- Severe abdominal pain
- Fever
- Excessive tiredness or breathlessness
- Swelling of the hands and face
- Severe headache or blurred vision
- Convulsion or impaired consciousness

ASSESS AND **MANAGE OTHER PROBLEMS**

COUNSEL THE MOTHER OR CAREGIVER **ON HOME CARE FOR THE YOUNG INFANT**

1. FLUIDS AND FEEDING
- Ensure good communication with the mother to promote early and exclusive breastfeeding (p. 17—18)
- Counsel the mother to breastfeed frequently, as often and for as long as the infant wants, day or night, during sickness and health (p. 18 - 20)

2. MAKE SURE THAT THE YOUNG INFANT IS KEPT WARM AT ALL TIMES
- Encourage mother to keep infant warm using skin-to-skin contact (p. 11)
- In cool weather, cover the infant's head and feet and dress the infant with extra clothing

3. MAINTAIN A HYGIENIC ENVIRONMENT
- Advise the caregiver to wash her hands with soap and water after going to the toilet, changing the infant's nappy and before each feed

4. SUPPORT THE FAMILY TO CARE FOR THE INFANT
- Help the mother, family and caregiver to ensure the young infant's needs are met
- Assess any needs of the family and provide or refer for management

5. WHEN TO RETURN

FOLLOW-UP VISITS

If the infant has:	Follow-up in:
JAUNDICE LOCAL BACTERIAL INFECTION: Purulent discharge of eye	1 day
LOCAL BACTERIAL INFECTION THRUSH SOME DEHYDRATION FEEDING PROBLEM POOR GROWTH AND INFANT LESS THAN 2 WEEKS	2 days
POOR GROWTH and infant more than two weeks	7 days
HIV INFECTION ONGOING HIV EXPOSURE HIV EXPOSED TB EXPOSED	At least once a month
AT RISK INFANT POSSIBLE SOCIAL PROBLEM	As needed

WHEN TO RETURN IMMEDIATELY:

Advise caregiver to return immediately if the young infant has any of these signs:
- Breastfeeding poorly or drinking poorly
- Irritable or lethargic
- Vomits everything
- Convulsions
- Fast breathing
- Difficult breathing
- Blood in stool

GIVE FOLLOW-UP CARE **FOR THE SICK YOUNG INFANT**

If there is a new problem, assess, classify and treat the new problem using the ASSESS AND CLASSIFY charts (p. 3 - 10)

LOCAL BACTERIAL INFECTION

After 1 or 2 days:
- **Discharge of eyes:** has the discharge improved? Are the lids swollen?
- **Red umbilicus:** Is it red or draining pus? Does redness extend to the skin?
- **Skin pustules:** Are there many or severe pustules?

Treatment:
- If condition remains the same or is worse, **refer**
- If condition is improved, tell the caregiver to continue giving the antibiotic and continue treating for the local infection at home (p. 13)

JAUNDICE

After 1 day:
- Look for jaundice (yellow eyes or skin)
- Look at the young infant's palms and soles. Are they yellow?
- Reassess feeding
- If palms and soles yellow, **refer**
- If palms and soles not yellow and infant feeding well, counsel mother to continue breastfeeding and to provide home care
- If you are concerned about the jaundice, ask the mother to return after one or two days or if the jaundice becomes worse

FEEDING PROBLEM

After 2 days:
- Ask about any feeding problems found on the initial visit and reassess feeding (p. 8 or 9)
- Counsel the caregiver about any new or continuing feeding problems. If you counsel the caregiver to make significant changes in feeding, ask her to bring the young infant back again after 5 days
- If the young infant has POOR GROWTH (low weight for age or has poor weight gain), ask the caregiver to return again after 5 days to measure the young infant's weight gain. Continue follow-up until the weight gain is satisfactory
- If the young infant has lost weight, **refer**

EXCEPTION:
If the young infant has lost weight or you do not think that feeding will improve, **refer**

POOR GROWTH

After 2 days in infant less than 2 weeks or 7 days in infant more than 2 weeks:
- Reassess feeding (p. 8 or 9)
- Check for possible serious bacterial infection and treat if present (p. 3)
- Weigh the young infant. Determine weight gain
- If the infant is no longer low weight for age, praise the caregiver and encourage her to continue
- If the infant is still low weight for age, but is gaining weight, praise the caregiver. Ask her to have her infant weighed again within 14 days or when she returns for immunisation, whichever is the earlier

EXCEPTION:
If you do not think that feeding will improve, or if the young infant has lost weight, **refer**

THRUSH

After 2 days in infant less than 2 weeks or 7 days in infant more than 2 weeks:
- Look for thrush in the mouth
- Reassess feeding. (p. 8 or 9)

Treatment:
- If thrush is worse check that treatment is being given correctly, and that the mother has been treated for thrush, if she is breastfeeding. Also consider HIV INFECTION (p. 7)
- If the infant has problems with attachment or feeding, **refer**
- If thrush is the same or better, and the baby is feeding well, continue with nystatin for a total of 7 days

Developmental screening

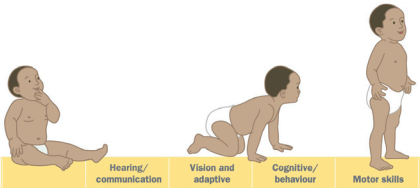
	Hearing/ communication	Vision and adaptive	Cognitive/ behaviour	Motor skills	Caregiver concerns
6 weeks					
10 weeks					
14 weeks Date __ /__ /__ Sign_____	☐ Startles to loud sounds	☐ Follows face or close objects with eyes	☐ Smiles at people	☐ Holds head upright when held against shoulder ☐ Hands are open most of the time	
6 months Date __ /__ /__ Sign_____	☐ Moves eyes or head in direction of sounds ☐ Responds by making sounds when talked to	☐ Eyes move well together (no squint) ☐ Recognises familiar faces ☐ Looks at own hands	☐ Laughs aloud ☐ Uses different cries or sounds to show hunger, tiredness, discomfort	☐ Grasps toy in each hand ☐ Lifts head when lying on tummy	
9 months Date __ /__ /__ Sign_____	☐ Babbles ('ma-ma', 'da-da') ☐ Turns when called	☐ Eyes focus on far objects	☐ Throws, bangs toys/objects ☐ Reacts when caregiver leaves, calms when she/he returns	☐ Sits without support ☐ Moves objects from hand to hand	
12 months Date __ /__ /__ Sign_____	☐ Uses simple gestures (e.g. lifts arms to be picked up) ☐ Has one meaningful word (dada, mama) although sounds may not be clear ☐ Imitates different speech sounds	☐ Looks for toys/ objects that disappear ☐ Looks closely at toys/objects and pictures	☐ Imitates gestures (e.g. clapping hands) ☐ Understands 'no'	☐ Stands with support ☐ Picks up small objects with thumb and index finger	

For Health Workers...

AT EVERY VISIT: Ask the parents or caregiver if they have any specific concerns about how their child hears, sees, communicates, learns, behaves, interacts with others and uses their hands, arms, legs and body.

Tick the boxes above if the caregiver says that the child CAN do the following or if it was OBSERVED during the visit. Try to elicit the behaviour or movement if not observed through spontaneous play and interaction.

If the child can complete the task, tick the box ☑. If the child cannot complete the task, cross the box ☒. If you were unable to assess the task, indicate ND (not done) next to the relevant task.



	Hearing/ communication	Vision and adaptive	Cognitive/ behaviour	Motor skills	Caregiver concerns
18 months Date __ /__ /__ Sign_____	☐ Understands names of at least 2 common objects e.g. cup ☐ Uses at least 3 words other than names	☐ Looks at small things and pictures	☐ Follows simple commands (e.g. 'come here')	☐ Walks alone ☐ Uses fingers to feed	
3 years Date __ /__ /__ Sign_____	☐ Child speaks in simple 3 word sentences	☐ Sees small shapes clearly at a distance (across room)	☐ Plays with other children/ adults ☐ Uses pretend play (e.g. feeds doll)	☐ Runs well ☐ Eats on own	
5-6 years Date __ /__ /__ Sign_____	☐ Speaks in full sentences ☐ Caregiver understands child's speech	☐ No reported/ observed vision problems (Use illiterate E chart if available)	☐ Interacts with children and adults ☐ Understands multiple commands (e.g. 'go to the kitchen and bring me your plate')	☐ Hops on one foot ☐ Holds with fingers at top or middle of pencil or stick to draw ☐ Dresses self	
REFERRED TO:	☐ Speech therapy ☐ Audiology ☐ Doctor	☐ Doctor ☐ Optometrist ☐ Ophthalmic nurse ☐ Occupational therapist	☐ Occupational therapist ☐ Doctor ☐ Psychologist ☐ Speech therapist	☐ Physiotherapist ☐ Occupational therapist ☐ Doctor	

If specified health professional not available, refer to one of the following health professionals for an initial developmental assessment: Doctor/physiotherapist/occupational therapist/speech therapist

CARE OF YOUNG INFANT AGED BIRTH UP TO 2 MONTHS

Name: _____ Sex: ○ Male ○ Female Age: _____

HC: _____cm Weight: _____kg Temp: _____

Date: _____Time:_____

CHECK: Has the baby just been delivered? If yes, follow the Helping Babies Breathe approach

ASK: Does the baby have any problems? If yes, record here: _____

_____

ASK: Has the baby received care at another health facility since birth? If yes, record here: _____

_____

_____

_____

_____

CHECK FOR POSSIBLE BACTERIAL INFECTION AND JAUNDICE (ALL YOUNG INFANTS)

ALWAYS classify:

○ convulsions with this illness ○ apnoea

Breaths per minute: _____ Repeat (if required): ____ ○ fast breathing

○ severe chest indrawing ○ nasal flaring or grunting ○ bulging fontanelle

○ fever (37.5°C or above) or low temperature (below 35.5 °C or feels cold)

○ only moves when stimulated

○ pus draining from eye ○ sticky discharge from eyes

○ umbilical redness If yes, does it extend to skin or is pus draining ○

○ skin pustules present If yes, are they many or severe ○

○ jaundice if age less than 24 hours ○ jaundice appearing after 24 hours of age

○ yellow palms and soles

DOES THE YOUNG INFANT HAVE DIARRHOEA? ○ yes ○ no

Diarrhoea for_____ days ○ very young infant (< 1 month) ○ blood in stool

○ lethargic or unconscious ○ restless and irritable ○ sunken eyes

Skin pinch: ○ normal ○ goes back slowly ○ goes back very slowly (> 2 secs)

If infant has not been seen by health worker before, CHECK FOR CONGENITAL PROBLEMS

Check Mother RPR results

○ Positive

○ Negative

○ Unknown

If positive, Mother is

○ Untreated

○ Partially treated

○ Tx completed < a month before delivery

Check for Priority Signs:

○ Cleft lip or palate

○ Imperforate anus

○ Ambiguous Genitalia

○ Nose not patent

○ Macrocephaly

○ Abdominal distension

○ Very low birth weight (≤ 2kg)

Check Head and Neck:

○ Microcephaly

○ Fontanelle or sutures abnormal

○ Swelling of scalp, abnormal shape

○ Neck Swellings, webbing

○ Face, Eyes, Mouth or nose abnormal

○ Unusual appearance

○ Other problems

Check Limbs and Trunk:

○ Abnormal position of limbs

○ Club foot

○ Abnormal Fingers and toes, palms

○ Abnormal chest, back and abdomen

○ Undescended testis or hernia

CONSIDER RISK FACTORS IN ALL YOUNG INFANTS

ALWAYS classify:

○ Signs/symptoms of congenital TB

○ Mother is on TB treatment

○ Admitted to hospital for more than three days after delivery

○ Infant weighed less than 2 kg at birth

○ Known neurological or congenital problem

CONSIDER HIV INFECTION

ALWAYS classify:

Has the baby had an HIV (PCR) test? ○ No test ○ Pos test ○ Neg test

If test is negative, is the child being breastfed (or breastfed in the 6 weeks before the test was done)?

○ yes ○ no

If child not tested, has the mother had an HIV test? ○ No test ○ Pos test ○ Neg test

THEN CHECK FOR FEEDING PROBLEM OR POOR GROWTH (all young infants);

Breastfeeding ○ no ○ yes _____ times in 24 hours
Difficulties with feeding ○ no ○ yes
Receiving other food or drinks ○ no ○ yes _____ times in 24 hours
If yes, what do you use to feed the baby? _____
Plot weight for age ○ low weight ○ not low weight
Weight gain ○ satisfactory ○ unsatisfactory
○ Thrush

ALWAYS classify:

If the young infant has any difficulty feeding, or is feeding less than 8 times in 24 hours, taking any other food or drinks, or is low weight for age AND has no indication to refer urgently to hospital, assess feeding. Record findings here:

ASSESS BREASTFEEDING

Breastfed in previous hour? ○ **yes** ○ **no**
If the mother has not fed in the previous hour, ask the mother to put the child to the breast
Observe the breastfeed for four minutes, check attachment:
Chin touching breast ○ yes ○ no
Mouth wide open ○ yes ○ no
Lower lip turned out ○ yes ○ no
More areola above than below the mouth ○ yes ○ no
○ **Not attached** ○ **Not well attached** ○ **Good attachment**
Is the young infant suckling effectively (slow deep sucks, sometimes pausing)?
○ Not sucking at all ○ Not suckling effectively
○ Suckling effectively

For non-breastfed infants:

Which breastmilk substitute is the infant receiving?
_____
Is enough milk being given in 24 hrs? ○ yes ○ no
Correct feed preparation? ○ yes ○ no
Any food or fluids other than formula? ○ yes ○ no
Feeding utensils? ○ cup ○ bottle
Utensils cleaned adequately? ○ yes ○ no

CHECK THE YOUNG INFANT'S IMMUNISATION STATUS (All young infants) :Underline those already given - Tick those needed today

Birth	○ BCG	○ OPV0		
6 weeks	○ DaPT-IPV-HB-Hib1	○ OPV1	○ PCV1	○ RV1
10 weeks	○ DaPT-IPV-HB-Hib2			

Doses needed today:

Next immunisation date:

CONSIDER OTHER RISK FACTORS AND PROBLEMS

ASK ABOUT THE MOTHER OR CAREGIVER'S HEALTH (RECORD FINDINGS AND MANAGEMENT)

TREAT THE SICK YOUNG INFANT

Return for follow-up in: _____ **Give any immunization today:** _____
Name: _____ **Designation:** _____
Signature: _____ **SANC no:** _____
Contact no: _____

“How do we make a positive impact through design?”

A design thesis exploration of social innovation. Premature infants face numerous environmental and biological risk factors post-discharge, which contribute significantly to adverse health outcomes.

Parents and caregivers of premature babies face complex environmental and socio-economic constraints, leaving them without the necessary tools and support to monitor their baby’s health post discharge, or to attend regular followup appointments.

NeoNu, a mobile application, was designed to address these challenges by enabling parents to track their infant’s health, identify warning signs, and facilitate communication with healthcare providers.

WILSON SCHOOL OF DESIGN